Lake Twelve Integrated Aquatic Plant Management Plan

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Prepared for

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Project Overview

Lake Twelve is a small, shallow lake located about one mile northeast of the City of Black Diamond in southeastern King County. Lake Twelve has historically supported growth of a variety of aquatic plant species. However, in recent years lake residents have reported increasing surface coverage by rooted macrophytes (vascular aquatic plants) that greatly impede usage of the waters. In particular, the invasive, non-native weed, **Eurasian watermilfoil**, *Myriophyllum spicatum*, has been documented in the lake since the mid-1970's, and is presently a dominant submersed member of the macrophyte community. In addition, dense stands of **white and pink water lily** (*Nymphaea odorata, Nymphaea spp.*), and to a lesser degree, watershield (*Brasenia shreberi)* and yellow waterlily *(Nuphar sp.),* choke much of the nearshore waters.

In order to effectively deal with nuisance macrophyte growth in the lake, King County Surface Water Management applied for and received a grant from the Washington Department of Ecology to complete an Integrated Aquatic Plant Management Plan (IAPMP) for Lake Twelve. The Lake Twelve IAPMP project also required completion of a aquatic plant survey, including bathymetric measurements, during the summer of 1994 to document current macrophyte conditions in the lake. Development of this management plan is a result of recommendations contained in the recent Lake Twelve Phase I Study Report (Envirovision, 1994). Specifically, the Phase I study recommended as an in-lake restoration measure the development of *an Integrated Aquatic Plant Management Plan (IAPMP) for control of macrophytes.*

The purpose of this Plan is to develop an implementation strategy for control of nuisance Eurasian watermilfoil and waterlilies to protect beneficial uses of Lake Twelve. The plan was crafted with the guidance of a Steering Committee composed of individuals representing the community, County and State agencies, and the consultant team. The Integrated Aquatic Plant Management Plan for Lake Twelve is part of a holistic lake management program designed to enhance and protect both the waterbody and watershed.

Problem Statement For Lake Twelve
Step A

Site Description

Lake Twelve is a small, shallow lake (42 acre; ave. depth=10 feet; max. depth=28 ft), located about one mile northeast of the City of Black Diamond in southeastern King County (Figure A-1). The shallow east end of the lake drains into a mature, 98 acre wetland (King County Wetland Inventory LCR91/92) that discharges into a small tributary of the Cedar River. While most of the 398 acre forested/wetland watershed is undeveloped, approximately 3/4 of the lake shoreline consists of residential lots.

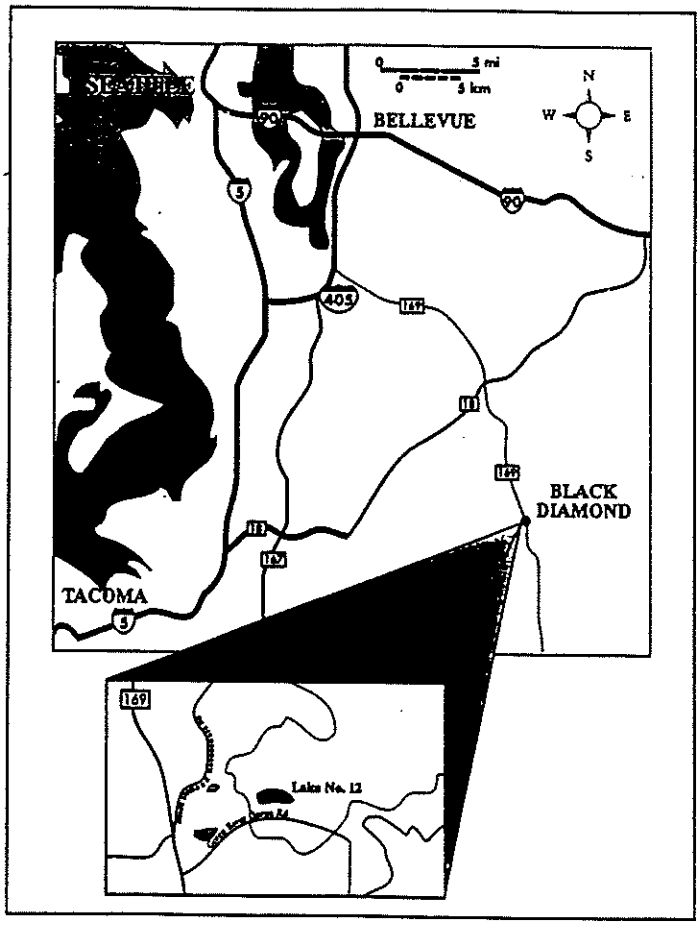

Figure A-1. Site map of Lake Twelve (adapted from Envirovision, 1994).

Aquatic Plant Species of Concern

Lake Twelve has historically supported growth of a variety of aquatic plant species (Bortleson et al, 1976; METRO 1978, 1979, 1980). However, in recent years lake residents have reported increasing surface coverage by rooted macrophytes (vascular aquatic plants) that greatly impede usage of the waters. This observation is supported by results of a recent survey showing aquatic plants colonizing much of the lake littoral out to depths in excess of 4 meters. In particular, the invasive, non-native weed, **Eurasian watermilfoil**, *Myriophyllum spicatum*, has been documented in the lake since the mid-1970's, and is presently a dominant submersed member of the macrophyte community. A summer, 1994 survey confirmed milfoil beds occupying an estimated area of 24 acres at water depths between 1 and 4 meters (See Steps F,G). This rooted, non-native species is notorious for its aggressive growth potential, and is listed as a *noxious* plant in the State of Washington. In addition, dense stands of **white and pink water lily** (*Nymphaea odorata, Nymphaea spp.*), and to a lesser degree, watershield (*Brasenia shreberi)* and yellow waterlily *(Nuphar sp.)*, choke much of the nearshore waters. The *Nymphaea* species found in Lake Twelve are also not native to Western Washington. The 1994 survey showed waterlily/ watershield beds occurring in shallow areas between shoreline and 3.25 m, an area of approximately 23 acres. It is important to note that the milfoil and waterlily zones are **not** mutually exclusive, but do overlap at depths between 1-3 m.

Water Uses Limited by Aquatic Plants

Boating, swimming, fishing, aesthetic enjoyment, and aquatic habitat have been severely impacted by dense aquatic plant beds. In particular, **boating access** via the public launch at the southeastern end of the lake becomes increasingly difficult as the growth season progresses. Often by late spring, private dock areas in the lake are completely inundated by surfacing macrophytes. By late summer when plants are tallest and densest, only a narrow lane of passage exists out to open water at the public boat launch (Figure A-2). Also, as swimming occurs off most of the developed shoreline, local residents are especially concerned about the **safety** of children recreating along the lake perimeter. In addition, the quality of Lake Twelve's **fishery** has deteriorated over the last few decades. As part of the final EIS for mining operations, a baseline study in 1983 by the University of Washington School of Fisheries revealed the presence of an overpopulation of smaller, stunted fish (Welch et. a., 1983). This condition was attributed to probable disruptions in predator-prey dynamics caused by dense macrophyte stands. The Lake Twelve system includes an extensive, high quality wetland that is utilized by a number of resident and migrant waterfowl. While this offers lake residents valuable **wildlife viewing opportunities**, the visual experience is unfortunately diminished by the presence of dense, unsightly weed mats in the lake.

Most importantly, with the frequent occurrence of mild winters in the Pacific Northwest, extensive and pervasive growth of aquatic plants in Lake Twelve is becoming a **year-round problem**.

Figure A-2. Photograph of Lake Twelve macrophyte beds taken from the state boat launch during July, 1994.

Aquatic Plant Management Goals
Step B

Extension of Phase I Goals

Aquatic plant management goals were established for Lake Twelve with the purpose of maximizing beneficial uses of the water body, preserving ecological functions, and minimizing aquatic plant control expenses. The aquatic plant management goals are consistent with those primary lake management goals formulated in the Phase I Study (Envirovision, 1994), which were:

- to maintain long-term water quality of the lake
- to maintain aesthetic character
- to control nuisance plants and provide long-term aquatic plant protection for beneficial species.

Specific IAPMP Objectives

Specifically, Lake Twelve Aquatic Plant Management Objectives are:

- to enhance water quality and beneficial uses of the lake by utilizing selective plant management techniques to control nuisance plant species in an environmentally sensitive and cost-effective manner
- to aggressively remove Eurasian watermilfoil (*Myriophyllum spicatum*) populations from all known locations in the lake
- to keep priority areas, the boat launch and shoreline residential areas, clear of plants for boating and swimming safety reasons
- to maintain sufficient lake habitat for fish and wildlife
- to preserve the high quality wetland adjacent to the east end of the lake
- to reduce overall management program costs by utilizing volunteer effort, where possible
- to complement concurrent watershed management program activities

Public Involvement
Step C

Steering Committee Formed

From project start-up, the lake community as well as those with an interest in management of this lake were encouraged to actively participate in the planning process. The plan itself was crafted by King County Surface Water Management and the consultant team in conjunction with a ***steering committee*** composed of individuals representing the lake community and King County. Fran Solomon (King County SWM) served as project manager. Consultant team members were Maribeth Gibbons of WATER Environmental Services, Inc. and Harry Gibbons KCM, Inc. The Lake Twelve Integrated Aquatic Plant Management Plan (IAPMP) Steering Committee consisted of the following members:

Esko Cate (Lake Twelve Association)
Dick Hansen (Lake Twelve Association)
Carolyn/Dave Carter (Lake Twelve Association)
Bill Kombol (Palmer Coking Coal Co.)

Throughout plan development, input and review by the committee were essential to insure creation of a unique planning document that reflected community support. In addition to maintaining frequent written and phone contact with each other, the Committee formally met four times during the course of the project: May 9, June 27, September 28, November 22, 1994. Committee members also kept the larger community informed as to the status of the emerging plan by holding informal meetings and publishing newsletters.

Workshops Conducted

As part of the Lake Twelve IAPMP Project, two public workshops were conducted by the Steering Committee/King County SWM/Consultant project team to update the community and other interested groups on project results. The first workshop, held on October 13, 1994, presented results of the 1994 aquatic plant/bathymetric survey with discussion of control implications. The second workshop, held on November 29, 1994, reviewed the entire draft plan, including presentation of potential treatment scenarios with the purpose of helping the community to select a preferred integrated treatment option. Following these formal workshops, additional meetings and communications were conducted by the Steering Committee with individual tribal groups, agencies and citizens regarding plan specifics. Steering committee meeting notes and Workshop notices are contained in Appendix A.

Waterbody/Watershed Features
Step D

The Lake Twelve watershed and lake water quality were characterized during 1991-1993 in a Phase I study funded by the Washington State Department of Ecology (Envirovision, 1994; Welch et al., 1993). Other sources of background data on Lake Twelve include: Environmental Impact Statement evaluations (U S Department of Interior, 1987), aquatic plant investigations (Metro, 1978, 1979, 1980), studies and surveys (Smayda, 1988, (Bortleson et. al.,, 1976), and King County wetland surveys. The following is a brief summary of pertinent information on the Lake Twelve watershed condensed from the above-mentioned sources. The reader is referred to these documents for more specific data.

Physical Features

Lake Twelve is a small (42 acre), shallow lake situated in the Cedar River basin in southeastern King County one mile northeast of the City of Black Diamond. The lake has an average depth of 10 feet (ft) or 3.05 meters (m), a reported maximum depth of 28 ft (8.5 m), and volume of 598 x 10^3 cubic meters (m^3). The small Lake Twelve watershed (398 acre) is largely undeveloped (Figure D-1), with 74 residential properties concentrated around the shoreline proper. Forestland and bog-type wetland comprise 86% of the total watershed, while lake and shoreline make up about 11%, and 3% of the watershed consists of the John Henry mining noise berm (owned by the Pacific Coast Coal Company). The Lake Twelve wetland (136 acres, including 43 acres open water) is a significant system, supporting five different vegetative classes, and is currently being considered for reclassification as a Class 1(c) wetland (Envirovision, 1994).

Hydrologic Features

Lake Twelve does not exhibit one significant, controllable inlet or outlet, as water flows both into and out of the lake through more diffuse avenues. In particular, water exits the lake through the large wetland as well as a channel draining the wetland along the eastern shore. This small outflow stream is the headwaters of Rock Creek, an extremely valuable salmonid-bearing system that eventually discharges into the Cedar River. The Phase I Study's hydrologic budget revealed approximately 86% of water inputs occurring by ungauged inflow and surface drainage along the north shore, while 85% of the total outflow was through discharge to the wetland. There is also evidence that during drier summer months, inflow to the lake may occur through groundwater discharge or from the wetland. Lake Twelve has a moderately low flushing rate, estimated to be 2.5 times/year.

Figure 1-2 Landuse in the Lake 12 & Wetland LCR-91/92 Subcatchments

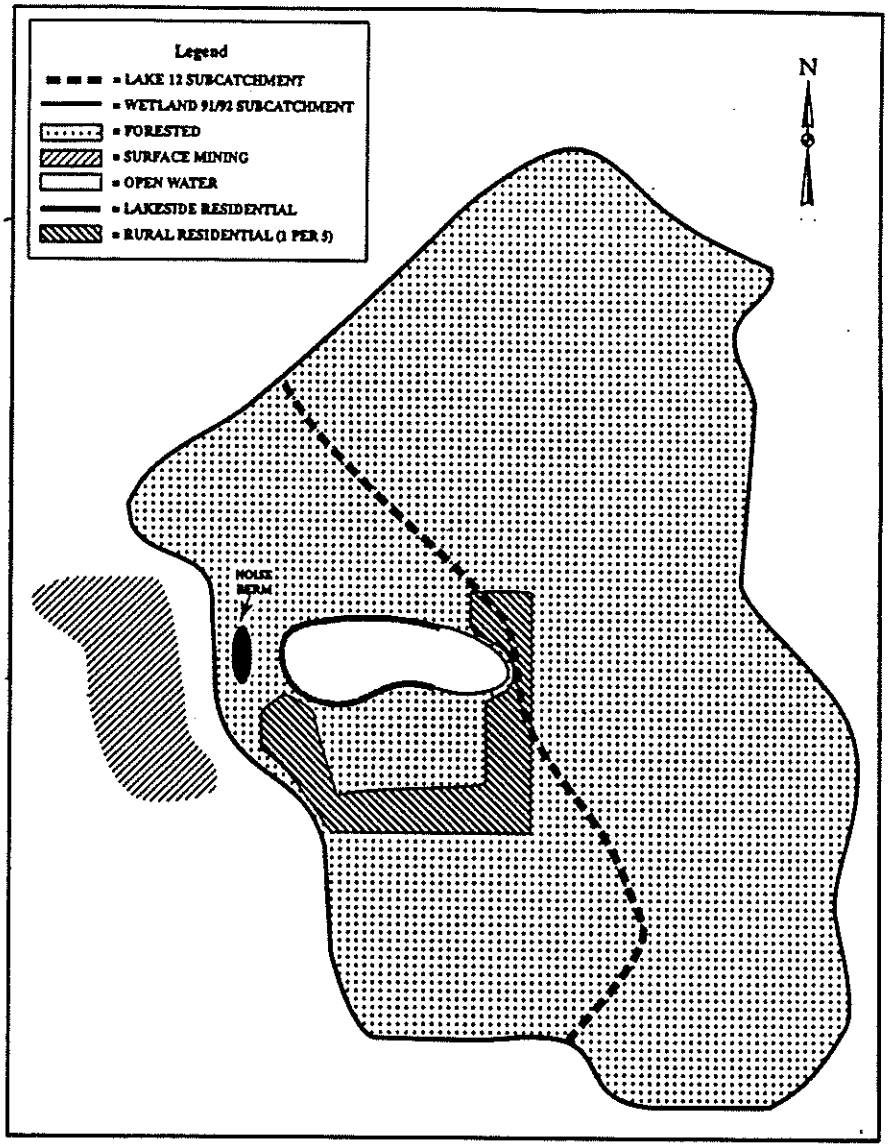

Figure D-1. Lake Twelve watershed (adapted from Envirovision, 1994).

Trophic Characteristics

Trophic state indicators developed for Lake Twelve as part of the Phase I study suggested good water quality and clarity. Concentrations of total and soluble phosphorus and nitrogen, nutrients essential for algal growth, were found to be low. During the Phase I study, average summertime chlorophyll *a* concentrations, a measure of algal growth, were moderate, as well. Algal blooms have been reported in past years, but do not appear to be an ongoing annual event in Lake Twelve.

Biological Community

A baseline fishery assessment of Lake Twelve conducted in 1983 revealed a predominantly warm-water fishery, composed mostly of brown bullhead, pumpkinseed, and to a lesser extent, yellow perch (see citation in Welch et. al., 1993). The lake also supports an annually stocked rainbow trout fishery managed by Washington Department of Fish and Wildlife (WDFW) which receives heavy angling pressure in the early season. The Phase I study showed that the zooplankton (microscopic invertebrate) community of Lake Twelve supported large-bodied crustaceans, including *Daphnia* sp., an important algal grazer, and planktivore food source. At the same time, the phytoplankton community was composed primarily of Chrysophytes (yellow-greens and diatoms), and Chlorophytes (greens). Cyanophytes (blue-greens) were a minor component occurring mostly during the summer months. Phytoplankton composition and concentrations indicated relatively low productivity conditions in the lake.

Sediment Characteristics

The Phase I study (spanning 1991-1993) estimated inorganic sedimentation rates to be approximately 2 millimeters per year (mm/yr), a relatively low rate compared to other regional lakes (3-5 mm/yr). However, Lake Twelve sediments were characterized as having high organic content (40-50%). The small size and shallow nature of the lake combined with enriched sediments translate into a large area of the lake being available for aquatic plant colonization. Indeed, Lake Twelve has historically supported substantial growth of rooted aquatic plants for several decades (Metro, 1978, 1979, 1980). Furthermore, bioassay studies revealed Lake Twelve sediments possessed qualities as conducive to milfoil growth as several regional lakes currently supporting substantial and healthy milfoil stands (Welch et al., 1993). Certainly, nuisance aquatic plant populations are considered a most significant problem affecting use of the lake by residents and visitors alike.

Lake Twelve Use Zones
Step E

Human Uses

Lake Twelve supports a variety of human and wildlife uses; as a result this body of water is considered a *multi-use resource.* The ***Lake Twelve Usage Map*** (Figure E-1a) displays primary zones of human and wildlife utilization. Approximately three quarters of the lake perimeter is **residentially developed** (74 lots). The lake offers many recreational opportunities to residents and visitors alike. Given its small, uniform size, most of the lake is utilized for **fishing, swimming, and boating,** although swimming occurs most frequently along the nearshore areas. Boating access occurs from private docks around the lake, as well as from a public Washington Department of Fish and Wildlife (WDFW) boat ramp located at the southeastern end of the lake. While historically used as a drinking water source until the mid-1980's, the lake water is currently used by many residents for **non-consumptive purposes** (Envirovision, 1994). Locations of water supply intakes are depicted in Figure E-1b. The largely undeveloped Lake Twelve watershed (primarily forest/wetland areas) offer unique opportunities for **aesthetic enjoyment.**

Fish, Waterfowl, and Wildlife Utilization

The lake system provides **nesting, forage and cover** for a variety of **fish, waterfowl and wildlife.** A baseline fishery assessment of Lake Twelve conducted in 1983 revealed a predominantly warm-water fishery, composed mostly of brown bullhead, pumpkinseed, and to a lesser extent, yellow perch (see citation in Welch et. al., 1993). The lake also supports an annually stocked rainbow trout fishery managed by WDFW (which receives heavy angling pressure). Interestingly, the earlier baseline study also indicated evidence of possible cutthroat trout reproduction occurring in Lake Twelve. An expansive, high quality wetland abuts the eastern end of the lake, providing habitat for migratory and resident waterfowl and other wildlife. Western grebes, mergansers, cormorants, coots and Canada geese have all been reported in the Lake Twelve system (Envirovision, 1994).

The wetland associated with Lake Twelve is the headwaters of Rock Creek. This 2.65 mile creek currently supports populations of four key species of anadramous salmonids: sockeye, coho and chinook salmon, and steelhead trout (King County Department of Public Works, Surface Water Management Division, Cedar River Current and Future Conditions Report, Seattle, WA., 1993.)

Figure E-1b. Lake Twelve Plat Map Showing Locations of Water Intakes.

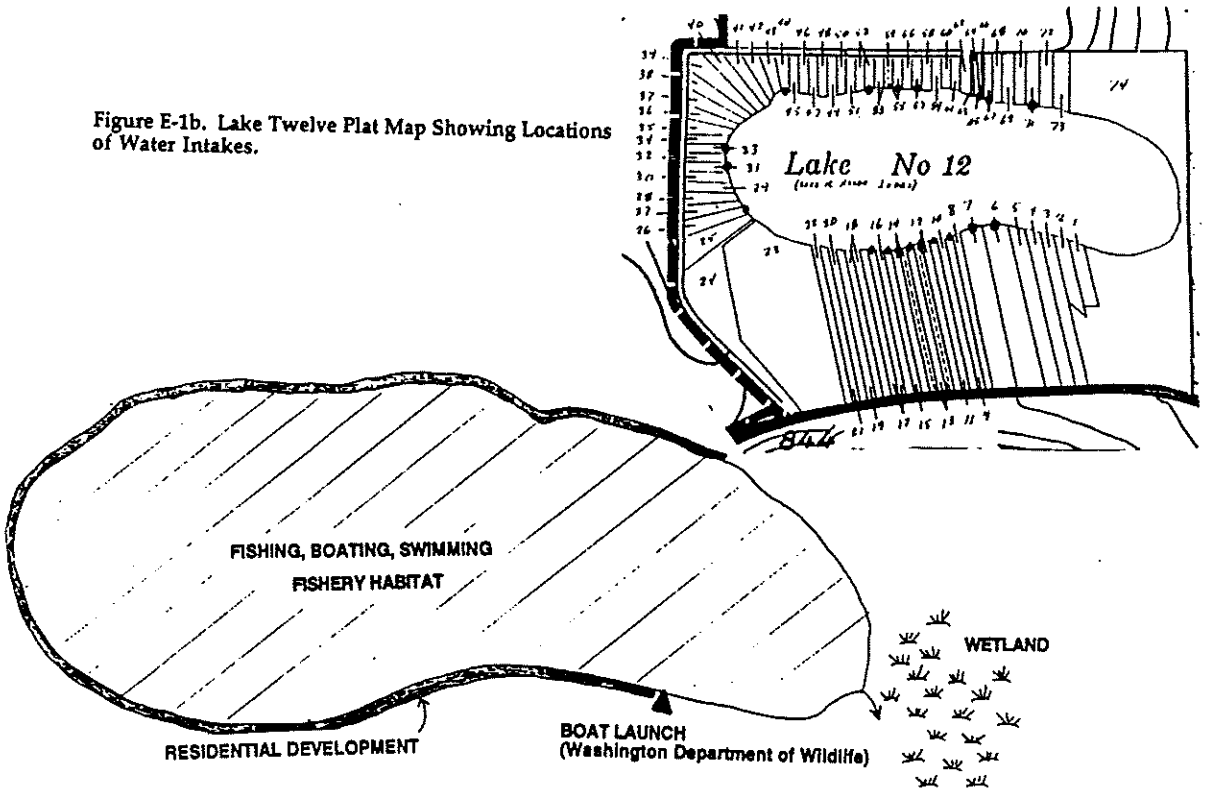

Figure E-1a. Lake Twelve Water Use Map.

Protected or Sensitive Flora or Fauna

A search of the Washington Department of Natural Resources Natural Heritage Data Base revealed no current record of threatened, endangered or sensitive plant species or communities residing in Lake Twelve or vicinity (See letter in Appendix B). A similar search of the data base for nongame species of concern by the Washington Department of Fish and Wildlife (See Appendix B) revealed in areas outside of Lake Twelve the presence of osprey (Green River Gorge), great blue heron (Grass Lake), and bald eagle (Lake Sawyer).

1994 Aquatic Plant/Bathymetric Survey
Step F

Dual Purpose of Survey

A combined bathymetric/aquatic plant survey was conducted on Lake Twelve during the months of July and August, 1994. The 1994 Lake Twelve survey was a joint volunteer/consultant team venture. WATER staff performed an intensive, three day survey during late July, while teams of lake volunteers conducted supplementary surveying around the lake from mid-July to mid-August. The aquatic plant survey was conducted at mid-growth season (during July-August, 1994) in order to meet project timelines. Survey purposes were twofold:

1) to take water depth measurements at representative points throughout the lake in order to construct an updated (approximated) bathymetric map of the lake. This data was useful in determining any changes in lake bottom contours occurring since the last official survey was performed by the Washington Department of Game in 1949.

2) to document current composition, extent, and biomass of the aquatic plant community in the lake. Limited aquatic plant surveys had been conducted on Lake Twelve in the past, but these, for the most part, included little or no quantitative measurements of plant biomass and coverage. A primary aim of the present survey was to supply critical plant biomass and areal coverage data for the lake.

Consultant Effort

During July 26-28, 1994, WATER's consultant team conducted a physical survey of Lake Twelve to document aquatic plant community composition and extent of growth. Field data on aquatic plant distribution and biomass were obtained by means of a motorboat using a transect sampling system. A series of eight primary transects was established around the lake perimeter (Figure F-2). Transects commenced at the wetland edge at the eastern end of the lake and continued around the lake at regular shoreline intervals.

At each transect point, calibrated floating line was securely stretched between a fixed shoreline point and a buoy set in deep water. Physical surveying on a transect began outside of the deepest edge of the plant beds (about 20 ft depth) and continued inward toward shore. Presence of submersed plants was visually determined along each transect by observation through an underwater viewer. In addition, along each of the eight transects, an echogram of the lake bottom illustrating plant beds was obtained using a high-resolution chart-recording fathometer. Fathometer tracings were especially useful when plant beds were difficult to detect visually with the underwater viewer,

particularly in deep or turbid waters. The complete series of fathometer recordings is presented in Appendix C. Nearshore plant beds were inspected from the boat with the underwater viewer while traveling between designated transects to provide as much continuum as possible around the lake littoral for mapping purposes. Surface and underwater photographs were also obtained for further visual documentation.

Water depth measurements and aquatic plant samples were taken along the transects at regular intervals from shore to the outer limit of growth using a modified rake sampler operated from the boat. In all, 27 quantitative plant samples were obtained during the late July survey of Lake Twelve. Samples were later analyzed in the laboratory for plant community composition and dry weight biomass measures according to Standard Methods (APHA, 1985). Species identifications were made using published keys for regional macrophytes (Hotchkiss, 1972; Warrington, 1994,1980; Hitchcock and Cronquist, 1981). Sediment brought up with each of the plant samples was also examined in order to provide a general characterization of local substrate type (e.g., mucky, sandy, clayey, gravely).

Plant Voucher Specimens

Whole plant specimens were also collected of the major aquatic plant species encountered in Lake Twelve during the summer, 1994 survey. These specimens were washed, dried, and mounted on specially labeled herbarium paper. These ***voucher specimens*** will serve as a permanent archival record of principal macrophytes occurring in the lake at this point in time.

Volunteer Effort

Eight citizen volunteers from the Lake Twelve community participated in the summer, 1994 lake survey. These were Esko Cate, Carolyn Carter, Dick, Toni, and Mark Hansen, Tom Grenfell, and Jill and Jeff Evans. WATER staff assisted the volunteer team in choosing locations of 16 supplementary survey points around the entire lakeshore (Figure F-2). The volunteers conducted their survey over a one month period from mid-July to mid-August, 1994. The surveying procedure utilized by the volunteers was a modification of that used by WATER's crew. Using rakes for sampling and calibrated floating line tied from shore to the outer depth of plant growth, the citizen crew performed water depth measurements and noted plant species types along each of these auxiliary survey transects. Sample specimens were collected of each type of aquatic plant encountered in the survey and presented to WATER for identification or verification. The plant and water depth information gathered by the volunteers formed an important supplement to quantitative and qualitative data collected by the consultant survey crew.

Aquatic Plant Map and Bathymetric Map Produced

As a result of both volunteer and consultant efforts, a total of 24 survey transects were established around Lake Twelve as part of the summer 1994 survey. Measurements by both crews along these transects generated a substantial data base from which a generalized bathymetric map (Figure F-1) and an aquatic plant

zone map (Figure F-2) were constructed. It is important to note that both maps reflect mid-summer, 1994 lake conditions during which lake levels were very low due to negligible seasonal precipitation patterns over the Pacific Northwest region. In fact, during the 4 week survey period, Lake Twelve water level dropped 14 inches (Esko Cate, Lake Twelve, pers. comm., 1994).

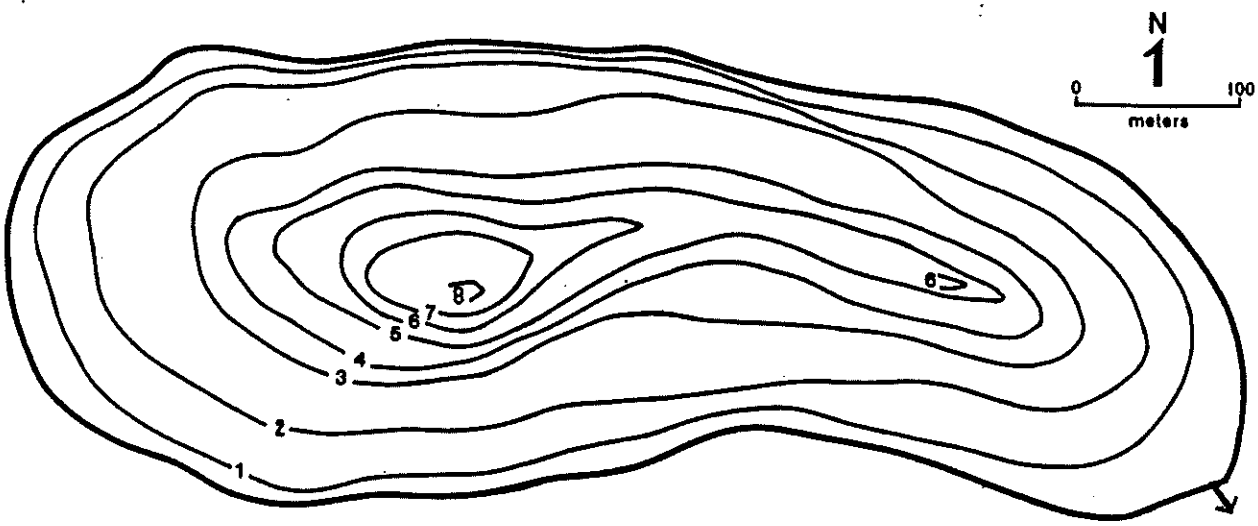

Figure F-1. Lake Twelve bathymetric map produced from survey conducted mid-July/mid-August 1994. Contours in meters.

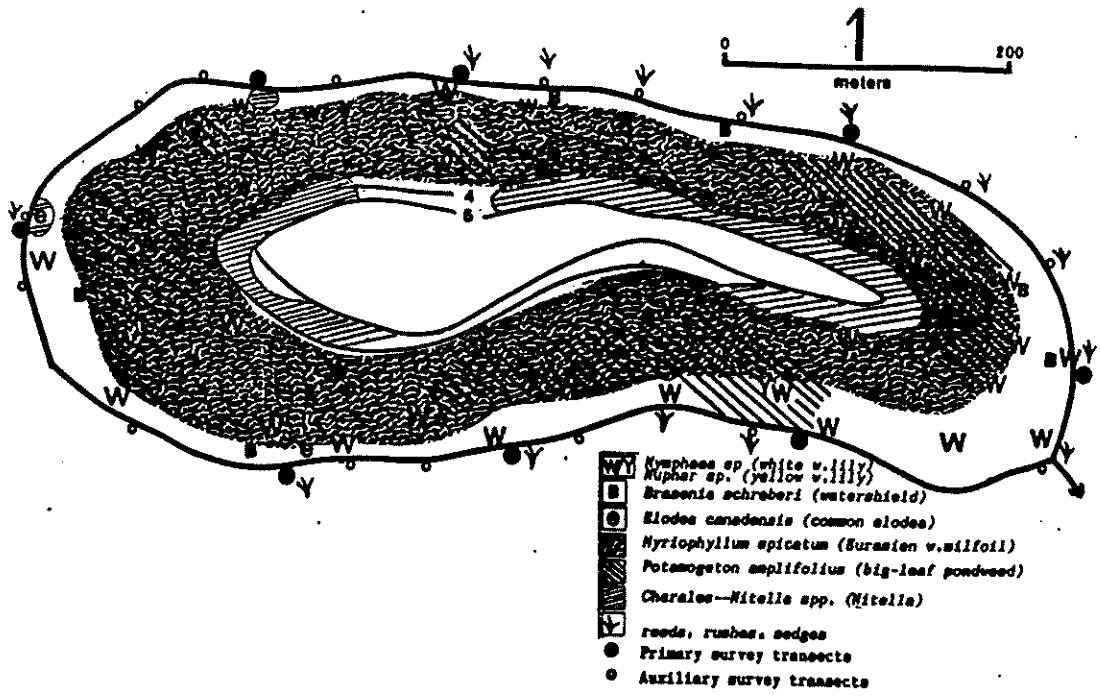

Figure F-2. Lake Twelve aquatic plant map produced from survey conducted mid-July/mid-August 1994. Contours in meters.

Lake Twelve Aquatic Plant Community
Step G

Plant Community Composition

The 1994 survey showed that aquatic plants in Lake Twelve occurred in mixed communities of varying densities around the entire lake and shoreline. More than a dozen different plant species were observed including emergent, floating-leaved and submersed forms. Table G-1 lists principal aquatic plant species found during the 1994 Lake Twelve survey along with their common names.

Extent of Coverage

Macrophytic growth in Lake Twelve generally followed the shallow littoral shelf out to depths in excess of 4 meters. Rooted, ***floating-leaved*** vegetation was quite prominent in the nearshore areas. In particular, surfacing white and ornamental pink waterlilies (*Nymphaea odorata* and *Nymphaea* spp., respectively) persisted around much of the lake littoral. Prominent stands of these non-native lilies inhabited the eastern and southern portions of the lake where the littoral shelf broadens. Scattered pockets of native watershield (*Brasenia schreberi)* and yellow water lilies (*Nuphar* sp.) were also present along several shoreline areas. The 1994 survey showed waterlily/watershield beds occurring in shallow areas between shoreline and 3.25 m (10.5 ft), an area of approximately 23 acres.

Noxious Weed Species Present

Eurasian watermilfoil, *Myriophyllum spicatum,* was found to be a dominant member of the ***submersed macrophyte*** community of Lake Twelve. This invasive, exotic weed has been documented in the lake since the mid-1970's (Metro, 1978, 1979, 1980). The summer, 1994 survey confirmed milfoil beds occupying an estimated area of 24 acres at water depths between 1 and 4 meters. This rooted, non-native species is notorious for its aggressive growth potential, and is listed as a *noxious* plant in the State of Washington. It is important to note that the milfoil and waterlily zones are not mutually exclusive, but do overlap at depths between 1-3 m (3.2-10 ft).

Other important members of the submersed community in Lake Twelve occurring within the milfoil/waterlily zones included mixed stands of *Potamogeton amplifolius* (big-leaf pondweed), *P. pusillus-berchtoldii* (narrow-leaved pondweed), and water bulrush (*Scirpus subterminalis*). *Elodea canadensis* (common waterweed), and *Naias flexilis* (naiad) also occurred in the Lake Twelve community, but to an even lesser extent. The rooted, submersed plant forms do not appear to cover the lake bottom uniformly, but exhibit a scattered, patchy distribution. Plant growth was extremely sparse in waters deeper than 4.25 m (14 ft), with only the rootless, macrophytic algae, *Nitella* spp. (Charales) occurring in very low densities. The genus *Nitella* is a common algal

inhabitant of soft-water or slightly acid lakes. The presence of this algae, which derives its nutrition from solution, suggests successful competition with planktonic algae for soluble nutrient reserves in the lake water column. Also, as a rootless algae, *Nitella* spp. does not directly compete with rooted macrophytes which extract nutrients primarily from the sediments (Smart, 1990), although it may come into competition with the submersed species *Elodea canadensis* which can detach from the bottom and form floating mats.

Emergents such as Iris (*Iris* spp.), rushes (*Juncus* spp., *Scirpus* spp.) and reeds (*Typha* sp.), sedges and grasses were also present in patches around the lakeshore perimeter. These emergent plants transition to a mature bog-type wetland area that abuts the eastern shoreline of the lake. The wetland is most likely responsible for the highly colored, humic nature of the lake water.

The 1994 survey generally showed submersed plant growth extending from a depth of about 0.5 m (1.6 ft) to 4.5 m (15 ft), representing about 75-80% of total lake surface area. Limits of submerged macrophytic growth are graphically depicted by fathometer tracings of lake bottom taken along the eight primary survey transects established around Lake Twelve for the 1994 survey (Appendix C). Inspection of the fathometer recordings reveal the bulk of growth occurring between the 1 and 3.25 m (3.2-10.5 ft) depth contours. Indeed, biomass samples typically showed maximal measures within these depths (See discussion on Biomass Patterns). The outer growth limit was further verified by failure to obtain any biomass samples at the 5.25 m (17 ft) depth along the survey transects.

TABLE G-1.
AQUATIC PLANT SPECIES FOUND DURING 1994 SURVEY OF LAKE TWELVE

Species	Common Name
Myriophyllum spicatum	Eurasian watermilfoil
Nymphaea odorata	White waterlily
Nymphaea spp.	Ornamental waterlilies (red/pink)
Nuphar spp.	Yellow waterlily, cow-lily
Brasenia schreberi	Watershield
Potamogeton amplifolius	Big-leaf pondweed
P. pusillus/berchtoldii	Small pondweed
Potamogeton sp.	thin-leaved pondweed
Elodea canadensis	Common elodea
Scirpus subterminalis	Water bulrush
Utricularia sp.	Bladderwort
Eleocharis sp.	Spikerush
Nitella spp.	Nitella (macroalgae)

Outer Limits to Growth

Mucky sediments brought up with biomass samples suggest that Lake Twelve sediments may be quite productive and a good potential source of nutrients for submersed plant growth. This potential was recently confirmed by bioassay studies conducted by Welch et. al. (1993). However, macrophytic growth in this lake may actually be more limited by light within the water column. Indeed, the presence of dissolved and particulate matter in the water column can result in greater attenuation of light with depth because of scattering and absorptive effects. Reduction of available light at greater depths can act to restrict submerged plant growth to shallower areas where light availability may be greater. The highly colored nature of the water most likely plays an important part in restricting plant growth in this lake. Using a regression model developed by Canfield et. al. (1985), Welch and associates (1993) predicted the maximum depth of colonization in Lake Twelve to be 4.1 m (13.5 ft), based on a mean annual secchi depth of 3.7 m (12.2 ft). Indeed, this depth was very close to the limits of growth observed during this planning investigation. [Note: Secchi depth is a measure of water transparency obtained by lowering a black&white disk into the water until it cannot be seen.]

Biomass Patterns

Table G-2 presents macrophyte species composition and biomass data (as grams per square meter, dry weight) for samples collected during the 1994 survey from selected depths along the eight primary survey transects in Lake Twelve. Macrophyte biomass was found to vary both by water depth and sampling site within Lake Twelve. Floating-leaved species, *Nymphaea odorata* and *Brasenia schreberi*, and the rooted, submersed *Myriophyllum spicatum*, dominated macrophyte biomass measures. These quantitative results confirmed other visual and qualitative observations of prominence of these species in the lake. For the 1994 samples collected, milfoil biomass ranged from 1 to 201 g/m^2, averaging 88 g/m^2, and showing a peak between depths of 2-3 m (6.5-10 ft). Inspection of the 1994 milfoil sample data revealed somewhat higher dry weight measures along the eastern and northern transect areas in the lake. *Nymphaea* spp. were more pronounced at depths between 1-2 m around the entire lake perimeter, with samples ranging from 82 to 174 g/m^2, and averaging 121 g/m^2. The one *Brasenia* sample collected at a 2.5 ft depth posted a dry weight measure of 120 g/m^2, but appeared to be representative of other nearshore beds around the lake.

With the exception of *M. spicatum*, the biomass measures of principal species obtained during the late July, 1994 survey of Lake Twelve were generally similar to quantitative data collected in August, 1991 by Welch et. al. (1993). The two surveys used comparative sampling methodology, but differed in total number of sites sampled and total number of samples collected. The present survey sampled 8 stations around the lake and collected 27 discrete samples, while the 1991 survey by the University of Washington sampled 4 sites and gathered 40 samples in all. In particular, *Nymphaea* spp. demonstrated a 1994 sample range of

TABLE G-2

Lake Twelve Macrophyte Biomass (grams/sq. meter) for Samples Collected Along Primary Survey Transects. Each Transect Extended from Shoreline to the 20 Foot Depth Mark. Macrophyte Biomass Survey Was Performed During July 26-28, 1994. Non-native Species Are Listed In Bold Type.

Transect(Lot#)	Depth (m)	Species		Dry Wt. (g/sq. m)	Tot Dry Wt. (g/sq. m)	% Composition
#1(L-74)	0.76m (2.5 ft)	*Brasenia schreberi*	watershield	120.00		95.82%
		Scirpus subterminalis	water bulrush	5.23		4.18%
					125.23	
	1.0m (3.25 ft)	***Nymphaea odorata***	white waterlily	**173.80**		**100.00%**
					173.80	
	1.75m (5.75 ft)	***Myriophyllum spicatum***	Eurasian watermilfoil	**62.90**		**80.54%**
		Potamogeton amplifolius	big-leaf pondweed	15.20		19.46%
					78.10	
	3m (10 ft)	***Myriophyllum spicatum***	Eurasian watermilfoil	**201.40**		**100.00%**
					201.40	
	3.7m (12 ft)	***Myriophyllum spicatum***	Eurasian watermilfoil	**17.33**		**100.00%**
					17.33	
	3.7m (12 ft)	***Myriophyllum spicatum***	Eurasian watermilfoil	**8.00**		**100.00%**
					8.00	
#2(L-3)	1.5m (5 ft)	*Potamogeton amplifolius*	big-leaf pondweed	8.57		87.41%
		Scirpus subterminalis	water bulrush	1.23		12.59%
					9.80	
	2.0m (6.5 ft)	***Myriophyllum spicatum***	Eurasian watermilfoil	**50.70**		**71.41%**
		Potamogeton amplifolius	big-leaf pondweed	20.30		28.59%
					71.00	
#3(L-73)	2.0m (7.5 ft)	***Myriophyllum spicatum*** (plants to surface)	Eurasian watermilfoil	**66.10**		**100.00%**
					66.10	
	3.5m (11.5 ft)	***Myriophyllum spicatum***	Eurasian watermilfoil	**10.87**		**70.41%**
		Nitella sp.	nitella	4.47		28.94%
		Utricularia sp.(trace)	bladderwort	0.10		0.65%
					15.43	
	5.2m (17 ft)	*Nitella sp.*	nitella	1.47		89.80%
		Myriophyllum spicatum	Eurasian watermilfoil	**0.17**		**10.20%**
					1.63	
#4(L-12)	1.4m (4.5 ft)	***Nymphaea odorata***		82.00		100.00%
					82.00	
	2.3m (7.5 ft)	*Potamogeton amplifolius*	big-leaf pondweed	32.57		99.09%
		P. berchtoldii(pusillus)	small pondweed	0.23		0.71%
		Scirpus subterminalis (tr)	water bulrush	0.07		0.20%
					32.87	
	2.4m (8 ft)	***Myriophyllum spicatum***	Eurasian watermilfoil	**82.57**		**100.00%**
					82.57	
	5.5m (18 ft)	no plants in sample			0	
#5(L-55)	2.75m (9 ft)	***Myriophyllum spicatum***	Eurasian watermilfoil	**123.37**		**100.00%**
					123.37	
	3.0m (10 ft)	***Myriophyllum spicatum***	Eurasian watermilfoil	**119.33**		**100.00%**
					119.33	
	3.4m (11ft)	***Myriophyllum spicatum***	Eurasian watermilfoil	**40.87**		**99.51%**
		P. berchtoldii(pusillus)	small pondweed	0.20		0.49%
					41.07	
	5.5m (18 ft)	no plants in sample			0	

Table G-2. (con't) Lake Twelve macrophyte biomass ...survey performed July 26-28, 1994.

Transect	Depth (m)	Species	Common name	Dry Wt. (g/sq. m)	Tot Dry Wt. (g/sq. m)	% Composition
#6(L-20)	1.8m (6 ft)	***Myriophyllum spicatum***	Eurasian watermilfoil	59.37		95.70%
		Nuphar polysepalum (very young plant)	yellow waterlily	2.67		4.30%
					62.03	
	2.6m (8.5 ft)	***Myriophyllum spicatum***	Eurasian watermilfoil	11.43		99.71%
		Nuphar polysepalum (very young plant)	yellow waterlily	0.03		0.29%
					11.47	
#7(L-47)	2.5m (8 ft)	***Myriophyllum spicatum***	Eurasian watermilfoil	57.83		100.00%
					57.83	
	2.75m (9 ft)	***Myriophyllum spicatum***	Eurasian watermilfoil	89.53		100.00%
					89.53	
	4m (13 ft)	*Nitella sp.*	nitella	46.13		86.23%
		Myriophyllum spicatum	Eurasian watermilfoil	5.37		10.03%
		Elodea canadensis	common elodea	2.00		3.74%
					53.50	
#8(L-33)	1.4m (4.5 ft)	***Nymphaea odorata***	white waterlily	106.50		91.73%
		Myriophyllum spicatum	Eurasian watermilfoil	9.60		8.27%
					116.10	
	2.0m (6.5 ft)	*Potamogeton amplifolius*	big-leaf pondweed	68.40		100.00%
					68.40	
	3.0m (9.5 ft)	*Potamogeton amplifolius*	big-leaf pondweed	7.60		86.69%
		Myriophyllum spicatum	Eurasian watermilfoil	1.17		13.31%
					8.77	

82 to 174 g/m^2 and a range of 26 to 197 g/m2 in 1991. In contrast, the 1994 range in milfoil biomass (1-201 g/m^2) was nearly triple that of the 1991 (4-74 g/m^2), with average measures (88 g/m^2) almost four times that computed in 1991 (25 g/m^2). It is important to note that annual variation in plant populations within the same waterbody is a common phenomenon, dependent on a variety of meteorological patterns and environmental conditions. Furthermore, milfoil biomass measures for both 1991 and 1994 were low to moderate compared to other regional lakes infested with this exotic weed (e.g., Green Lake). Nevertheless, the impact to recreational use of the lake in both survey years was most problematic. This is due to milfoil's growth habit whereby most of the vegetative mass is concentrated in the upper "canopy" of the plant.

Finally, plant biomass measures obtained during the late July, 1994 survey may not have represented peak growth conditions for the year. Since hot, dry conditions persisted in the region well into September, growth of aquatic plants and correlative problems in Lake Twelve appeared to have continued as well.

Problem Plant Zones

The entire area of the lake between depths of 1.25 m and 4.25 m is the highest priority problem zone because of the presence of the noxious weed, **Eurasian watermilfoil** (*Myriophyllum spicatum*). These watermilfoil areas justify use of special, aggressive control action to remove nuisance populations, if possible. The milfoil beds in Lake Twelve are well-established, having persisted for at least several decades, but are not yet at prohibitively high densities. Another problem zone is the littoral shelf (0.5 m to 3.25 m) which is heavily populated with **waterlilies and watershield.** These surfacing, floating-leaved plant beds make shoreline access as well as swimming, wading or other contact recreational use most difficult and dangerous. In particular, the WDFW boat access area is so clogged with surfacing vegetation as to make launching even a small boat into the lake most cumbersome. It is also important to note that these waterlilies are not native, but rather, introduced plant species.

Beneficial Plant Zones

Lake Twelve supports a warm-water fishery and planted trout fishery, as well as waterfowl and other wildlife. **Native beds** of pondweed, elodea and naiad form an important source of food and refuge in the lake for these and other small aquatic life. Most importantly, the mature **wetland** stand adjacent to the eastern end of the lake is recognized as a high quality beneficial zone that should be protected as part of the overall aquatic plant management plan.

Review of Aquatic Plant Control Alternatives
Step H

A variety of methods (chemical, mechanical, biological, physical) exist for treatment of nuisance aquatic plant populations, such as Eurasian watermilfoil and waterlilies, in order to protect beneficial uses of a waterbody. This section reviews selected treatment methodologies currently available for aquatic plant control in the State of Washington. These treatment options will be examined in terms of suitability for controlling the two nuisance non-native plant types in Lake Twelve: Eurasian watermilfoil and white and colored ornamental waterlilies. These two plant forms are very different from each other in terms of morphology and structure, physiology, growth requirements, and growth habit. As a result, each requires different control tactics for maximum effectiveness. In other words, control methods that might be quite successful against submersed milfoil may not be appropriate for management of floating-leaved waterlilies. Thus, it is obvious that an integration of several control methods will be necessary to address the multi-species macrophyte problem in Lake Twelve. Indeed, Washington State has identified as the preferred alternative the use of an **integrated approach** to aquatic plant management. This involves selection of the best combination of methods after careful evaluation of economic, ecological, socio-political consequences within the context of whole lake and watershed management (WDOE, 1992; Gibbons et. al, 1994).

Two Different Plants Targeted for Control

Integrated Control Approach

With regard to exotic plant infestations, it is critical to consider possible consequences of a **no action alternative** on human use, habitat, and wildlife utilization of the resource. In particular, if aggressive, lakewide control tactics are not used to eliminate Eurasian watermilfoil populations from Lake Twelve, this exotic plant can be expected to continue colonization of all available littoral area. Left unchecked, watermilfoil has the potential to eliminate native stands, and further degrade water quality and aquatic life. Ultimately, it could create a worse weed problem that may result in higher future program costs and level of effort to manage this plant.

No Action Alternative

The selected options presented are the large-scale treatments: aquatic herbicide application (e.g. fluridone, glyphosate), mechanical dredging, grass carp introduction, and mechanical harvesting. Also considered are methods appropriate for smaller areas: hand-removal and bottom barrier application. These techniques do vary with respect to effectiveness against Eurasian watermilfoil and waterlilies. Dredging, hand removal, bottom barrier and systemic chemical applications such as SONAR (fluridone) and Rodeo (glyphosate) are intensive methods aimed at killing or removing *M. spicatum* and *Nymphaea* spp. including

Selected Treatment Options Listed

roots, and are considered aggressive methods. Mechanical harvesting is useful for short-term removal of large areas of surfacing plants, such as waterlilies, and is included in the discussion as a less intensive form of maintenance control. Use of herbivorous grass carp, offering **limited** control of milfoil at least initially, is also treated in the review as a result of recent availability of this method in Washington State and recent introduction to local waters (e.g., Silver Lake in Cowlitz County). Other types of large-scale control methods, such as mechanical rotovation and lake drawdown, are not considered appropriate for current use in Lake Twelve for reasons of operational logistics (surface/bottom obstructions, flocculent substrate) and site specific constraints(no controllable outlet), respectively, and are not discussed. Diver-operated dredging, a small-scale method, is also not considered appropriate for current use in Lake Twelve due to the presence of flocculent (loose, unconsolidated) sediments.

Each treatment alternative will be reviewed in terms of principal mode of action, effectiveness of treatment, human and environmental effects (safety, water quality, non-target organisms/plants), costs, and other special political/ administrative concerns. A summary of comparative data on these treatment alternatives (and others not currently considered appropriate for use in Lake 'Twelve) is presented in Table H-1. Potential mitigation measures are presented along with estimates of mitigation costs, where possible.

Mechanical Control Methods

Hydraulic (Suction) Dredging

Principle This is an intensive technique that involves removal of littoral sediments and associated rooted aquatic plants using hydraulic dredging equipment. Lake sediment removal is most often performed by means of a cutter-head hydraulic pipeline dredge (Cooke et. al., 1993). In terms of operation, plants/sediment loosened by the cutter head travels to the pickup head. The slurry is then suctioned up and carried back to the dredge barge through hoses. The sediment slurry is then piped off-site for disposal.

Control Effectiveness And Duration Large-scale sediment removal techniques can often provide multiple benefits to an aquatic system (Cooke et. al., 1993). Depending on the waterbody, possible enhancements include not only rooted macrophyte control, but also increased depth, and removal of nutrients or toxic substances. Efficiency of removal is dependent on equipment, sediment type and condition, with conventional dredges performing well on harder sediment. However, various types of portable hydraulic dredges are available in the U.S. that are more effective for small lakes with softer, flocculent substrate. Longevity of control is dependent on a number of factors including sedimentation rate (the lower the better), watershed-to-surface-

area ratios (nominally 10:1), and hydraulic residence time (the longer the better).

Advantages Dredging removes entire plants, including root systems, so regrowth is minimized. Plant pieces are collected and retained, and fragmentation spread is minimized (very important for control of milfoil). It can be used to cover areas larger than practicable for diver-operated dredging or diver hand removal, or where herbicides cannot be used. Human health and safety concerns are negligible where operations are conducted prudently.

Drawbacks Hydraulic dredging is very expensive and highly disruptive to the local environment. A major problem often involves finding suitable offsite disposal areas and transporting dredged materials to these sites. As a result, more specialized equipment and materials are required and the process can be much more costly. Short-term environmental effects include resuspension of sediments and localized turbidity increases in the area of treatment. Release of nutrients and other contaminants from enriched sediments can also be a problem. In addition, some non-target aquatic organisms and vegetation may be inadvertently removed during the process. However, if only a portion of the lake bed is dredged, impacts on benthic aquatic life should be short-lived (Cooke et. al., 1993).

Costs Dredging costs can be very variable, depending on density and volume of sediment removed, equipment condition, transport requirements of dredged material, and eventual use of dredged material (Cooke et. al., 1993). Hydraulic dredging costs typically range from a minimum of $\$2.25/m^3$ to $\$6/m^3$, although figures as high as \$20 to $\$50/m^3$ have been reported for special cases.

Permits Use of suction dredging does require hydraulic approval from the Washington State Department of Fish and Wildlife. Its use also requires a temporary modification of water quality standards from Ecology for increased turbidity. A local shoreline management permit may be needed. In addition, it will be necessary to obtain a letter of approval from the Washington State Department of Natural Resources.

Mechanical Harvesting

Principle Mechanical harvesting involves cutting plants below the water surface, with or without collection of cut fragments for offshore disposal. To achieve maximum removal of plant material, harvesting is usually performed during summer when submersed and floating-leafed plants have grown to the water's surface.

Conventional single-stage harvesters combine cutting, collecting, storing and transporting cut vegetation into one piece of machinery. Cutting machines are also available which perform only the cutting function. Maximum cutting depths for harvesters and cutting machines range from 5 to 8.2 ft with a swath width of

6.5 to 12.1 ft. Cooke et al. (1993) summarizes aquatic plant cutters and harvesters available in North America.

Control Effectiveness and Duration Since harvesting involves physical removal and disposal of vegetation from the water, the immediate effectiveness in creating open water areas is quite apparent. However, mechanical harvesting is essentially a mowing operation removing upper stem material, and duration of control is variable. Factors such as target plant type, frequency and timing of harvest, water depth, and depth of cut can influence duration of control. Harvesting has not proven to be an effective means of sustaining long-term reductions in growth of milfoil. Regrowth of milfoil to pre-harvest levels typically occurs within 30 to 60 days (Perkins and Sytsma, 1987), depending on water depth and the depth of cut.

Advantages Harvesting is most appropriately used for large, open areas with few surface obstructions. There is usually little interference with use of water body during harvesting operations. Harvesting also has the added benefit that removal of in-lake plant biomass also eliminates a possible source of nutrients often released during fall dieback and decay. This is important in those water bodies with extensive plant beds and low nutrient inputs from outside sources. Furthermore, harvesting can reduce sediment accumulation by removing plant organic matter that would typically decay and add to the bottom sediments. Depending on species content, harvested vegetation can be easily composted and used as a soil amendment. Mechanical harvesting costs can be relatively low compared to other physical/mechanical techniques.

Drawbacks Cut plant material requires collection and removal from the water. Harvesting creates plant fragments. While waterlilies do not reproduce by fragmentation, Eurasian watermilfoil can rapidly disperse and regrow by stem breakage. Thus, if plant control program objectives involve reduction of milfoil spread in the system, harvesting would not be an appropriate large-scale technique. Harvesting can be detrimental to non-target plants and animals (e.g., fish, invertebrates) associated with plant beds, which are removed indiscriminately by the process. Harvesting can lead to enhancement of growth of opportunistic plant species that may invade treated areas. Capital costs for machine purchase are high and equipment requires considerable maintenance.

Costs Harvesting program costs depend on factors such as program scale, composition and density of vegetation, equipment used, skill of personnel, and site-specific constraints. Detailed costs are not uniformly reported, so comparing project costs of one program with another can be difficult. Average costs of local harvesting operations, however, range from $200/acre to $700/acre.

Permits Mechanical cutting (including battery-operated equipment) does require hydraulic approval from the Washington Department of Fish and Wildlife. It is advisable to check with local government (King County) to determine current regulations applying to mechanical cutting operations in lakes.

Chemical Control Methods

Historically, use of aquatic herbicides was the principal method of controlling nuisance aquatic weeds in Washington. However, in recent years there has been a shift away from such a dominant practice and a move toward more selective herbicide use after thorough review of target species effectiveness, as well as other environmental, economic, political and social implications (WDOE, 1992).

The State of Washington currently permits use of only four aquatic herbicides to control aquatic weeds. They are the systemic herbicides *fluridone* and *glyphosate*, the contact herbicide *endothall*, and certain copper compounds. *Systemic herbicides* are absorbed by and translocated throughout the plant, capable of killing the entire plant roots and shoots. In contrast, *contact herbicides* kill the plant surface with which it comes in contact, leaving roots alive and capable of regrowth. The systemic herbicides, fluridone and glyphosate, have the best potential for use in Lake Twelve and are reviewed in more detail below.

Fluridone

Principle Fluridone, 1-methyl-3-phenyl-5-[3-trifluoromethyl)phenyl]-4(1H)-pyridinone, is a slow-acting, systemic type herbicide. Fluridone is available as the EPA-registered herbicide SONAR® (SePRO) for use in the management of aquatic plants in freshwater ponds, lakes, reservoirs, and irrigation canals. It is formulated as a liquid (SONAR 4AS) sprayed above or below surface, and in controlled release pellets (SONAR 5P, SONAR SRP) spread on the water surface. Fluridone is effectively absorbed and translocated by both plant roots and shoots (Westerdahl and Getsinger, 1988)

Control Effectiveness And Duration Fluridone demonstrates good control of submersed and emergent aquatic plants, especially where there is little water movement. Its use is most applicable for lake-wide or isolated bay treatments to control a variety of exotic and native species. Eurasian watermilfoil is particularly susceptible to the effects of fluridone. Lilies (*Nymphaea* and *Nuphar* spp.) may also show some short-term yellowing of plant tissues, but long-term efforts have not been documented. Typical fluridone injury symptoms include retarded growth, "whitened" leaves and plant death. Effects of fluridone treatment become noticeable 7-10 days after application, with control of target plants often requiring 60-90 days to become evident (Westerdahl and Getsinger, 1988). Because of the delayed nature of toxicity, the herbicide is best applied during the early growth phase of the target plant, usually spring-early summer.

Advantages As a systemic herbicide, fluridone is capable of killing roots and shoots of aquatic plants, thus producing a more long-lasting effect. A variety of emergent and submersed aquatic plants are susceptible to fluridone treatment. As a result of human health risk studies, it has been determined that use of fluridone according to label instructions does not pose any threat to human health (WDOE, 1992). Fluridone also has a very low order of toxicity to zooplankton, benthic invertebrates, fish, and wildlife.

Drawbacks Fluridone is a *very slow-acting* herbicide, and its effects can sometimes take up to several months. Because of the long uptake time needed for absorption and herbicidal activity, fluridone is not effective in flowing water situations. Because of the potential for drift out of the treatment zone, fluridone is not suitable for treating a defined area within a large, open lake. The potential exists for release of nutrients to the water column and consumption of dissolved oxygen from the decaying plants. Non-target plants may be affected, as a variety of plants do show degrees of susceptibility to fluridone treatment. Mitigation of lost vegetation may be necessary. As fluridone-treated water may result in injury to irrigated vegetation, there are label recommendations regarding irrigation delays following treatment.

Costs Treatment costs (materials and application) by private contractor for any of the formulations range from about $700 to $1000/acre, depending on scale of treatment.

Permits The use of aquatic herbicides does require receiving a short-term modification to State water quality standards from the Washington Department of Ecology prior to treatment. Local jurisdictions should be contacted for any required shoreline permits. For example, current King County Code should be consulted regarding aquatic plant control activities and any required shoreline permits for aquatic herbicide use.

Glyphosate

Principle Glyphosate (N-(phosphonomethyl)glycine) is a non-selective, broad spectrum herbicide used primarily for control of emergent or floating-leafed plants like water lilies. Glyphosate is a systemic herbicide that is applied to the foliage of actively growing plants. The herbicide is rapidly absorbed by foliage and translocated throughout plant tissues, affecting the entire plant, including roots. Glyphosate is formulated as RODEO® (Monsanto) for aquatic application.

Control Effectiveness And Duration Glyphosate is effective against many emergent and floating-leafed plants, such as water lilies (Nuphar and *Nymphaea* spp.) and purple loosestrife (*Lythrum salicaria*). According to the manufacturer, RODEO is **not** effective on submersed plants or those with most of the foliage below water. The herbicide binds tightly to soil particles on

contact and thus is unavailable for root uptake by plants. As a result, proper application to emergent foliage is critical for herbicidal action to occur. Symptoms of herbicidal activity may not be apparent for up to 7 days, and include wilting and yellowing of plants, followed by complete browning and death.

Advantages As a systemic herbicide, glyphosate is capable of killing the entire plant, producing long-term control benefits. Glyphosate carries no swimming, fishing, or irrigation label restrictions. Glyphosate dissipates quickly from natural waters, with an average half-life of 2 weeks in an aquatic system. The herbicide has a low toxicity to benthic invertebrates, fish, birds and other mammals.

Drawbacks As a non-selective herbicide, glyphosate treatment can have an effect on susceptible non-target emergent or floating-leaved plant species. While the possibility of drift may occur by spraying individual plants, it is expected to be negligible if application is made according to label instructions and permit instructions. There are use restrictions where glyphosate is applied within 1/2 mile of potable intakes in either flowing or standing waters. Current label restrictions on use require that active potable water intakes be shut off for a minimum of 48 hours after application or until measured glyphosate levels are below 0.7 ppm.

Costs Treatment costs (materials and application) by private contractor for any of the formulations average approximately $250/acre, depending on scale of treatment.

Permits Use of aquatic herbicides requires receiving a short-term modification to State water quality standards from the Washington Department of Ecology prior to treatment. Local jurisdictions should be contacted for required shoreline permits. For example, current King County Code should be consulted regarding aquatic plant control activities and any required shoreline permits for aquatic herbicide use.

Biological Control Methods

Interest in using biocontrol agents for nuisance aquatic plant growth has been stimulated by a desire to find more "natural" means of long-term control as well as reduce use of expensive equipment or chemicals. The possibility of integrating biological controls with traditional physical, mechanical, or chemical methods is an appealing concept. While development and use of effective biocontrol agents for aquatic plant management is still in its infancy, potentially useful candidates have been identified such as plant-eating fish or insects, pathogenic organisms, and competitive plants. Except for exotic species infestation, a realistic objective of biocontrol for aquatic vegetation is not the eradication, but the reduction of target plant species to lower, more acceptable levels (Cooke et. al., 1993). More importantly,

control of nuisance plants using biological agents will be a gradual process, although the effects should be long-lasting.

In the State of Washington, the only biological method currently available for aquatic plant control is the introduction of triploid (sterile) grass carp.

Triploid (Sterile) Grass Carp

Principle Grass carp or white amur (*Ctenopharyngodon idella* Val.) are exotic, plant consuming fish native to large rivers of China and Siberia. Known for their high growth rates and wide range of plant food preference, these fish can control certain nuisance aquatic plants under the right circumstances. Grass carp are most appropriately used for lake-wide, low-intensity control of submersed plants. Stocking rates are dependent on climate, water temperature, type and extent of plant species and other site-specific constraints. Grass carp require a permit from the Washington Department of Fish and Wildlife (WDFW). To avoid problems encountered in other areas of the country, Washington State regulations adopted in 1990 require:

1. Only sterile (triploid) fish can be planted;
2. Outlets and possibly inlets must be screened to prevent fish from getting into other water bodies;
3. Stocking will be defined by WDFW based on the current planting model. This is to insure that sufficient vegetation is retained for fishery and other habitat needs.

State fisheries personnel with WDFW should be contacted for more information on specific use and stocking of grass carp in Washington State waters.

Control Effectiveness And Duration Effectiveness of grass carp in controlling aquatic weeds depends on feeding preferences and metabolism; rates do appear to be temperature-dependent (WDOE, 1992; Cooke et. al., 1993). Triploid grass carp exhibit distinct food preferences which can vary from region to region in the U.S. Recent laboratory and field studies in Washington State have shown that some plant species appear to be highly preferred, such as the pondweeds, *Potamogeton crispus, P. pectinatus* and *P. zosteriformis;* others were variably preferred as coontail, *Ceratophyllum demersum,* and some plants not preferred such as watershield, *Brasenia schreberi.* Grass carp control effectiveness and duration are site-specific. In general, management studies in Washington waters indicate that substantial removal of vegetation by sterile grass carp may not become apparent until 3-5 years after introduction.

Advantages Depending on the problem plant species and other site constraints, proper use of grass carp can achieve long-term reductions in nuisance growth of vegetation, although not immediately. In some cases, introduction of grass carp may result in improved water quality conditions, where water quality

deterioration is associated with dense aquatic plant growth (Thomas et. al., 1990). Compared to other long-term aquatic plant control techniques (e.g., bottom tillage, bottom barriers), costs for grass carp implantation are relatively low.

Drawbacks Since sterile grass carp exhibit distinct food preferences, they do not graze all plants equally well, limiting their applicability. The fish may avoid areas of the water body experiencing heavy recreational use, resulting in less plant removal. Plant reductions may not become evident for several years. Mature waterlilies (*Nuphar* and *Nymphaea* spp.) do not appear to be effectively grazed by grass carp. While noxious Eurasian watermilfoil (*Myriophyllum spicatum*) is apparently not a highly preferred food type, especially where other edible native plants are available, effective grazing on milfoil has been demonstrated in the Northwest several years after implantation (M. Gibbons, unpublished data, 1994). Overstocking of grass carp could result in eradication of beneficial plants and have serious impacts on the overall ecology of the water body. Full ecological impacts of grass carp introductions in Northwest waters are still being evaluated. An escape barrier on the outlet (if present) is required to prevent movement of fish out of the system and avoid impacts on downstream aquatic ecosystems. There may be fish loss due to predation, especially by ospreys and otters.

Costs Based on the few large-scale grass carp implantations made in the State of Washington since 1990, costs can range from approximately $50/acre to $2000/acre, at stocking rates ranging from 5 fish/acre to 200 fish/acre and average cost of $10/fish (range $7.50/fish to $15.00/fish).

Permits Washington Department of Fish and Wildlife (WDFW) requires a game fish planting permit prior to grass carp introduction to a water body. In addition, if outlet screening is necessary, hydraulic approval is required from the WDFW. The Washington Department of Natural Resources Natural Heritage Program must be contacted for assessment of threatened or endangered plant species. Current King County Code should be consulted regarding aquatic plant control activities and any requirements for grass carp use.

Physical Control Methods

Hand-Digging

Principle Hand-digging and removal of rooted, submerged plants is an intensive treatment option. This method involves digging out the entire plant (stem and roots) with a spade or long knife and disposing residue on shore. In shallow waters less than 3 feet, no specialized gear is required. In deeper waters, hand removal can best be accomplished by divers using scuba or snorkeling equipment and carrying collection bags for disposal of plants.

Control Effectiveness And Duration Efficacy of plant removal depends on sediment type, visibility, and thoroughness in removing the entire plant, particularly the roots. A high degree of control over more than one season is possible where complete removal has been achieved.

Advantages The technique results in immediate clearing of the water column of nuisance plants. The technique is very selective in that individual plants are removed. It is most useful in sensitive areas where disruption must be kept to a minimum. Because the technique is highly labor-intensive, it is most appropriate for small-area, low plant density treatments. In these cases, the technique is very useful for aggressive control of sparse or small pockets of Eurasian watermilfoil. This method can also be useful for clearing pondweeds or *very small* patches of water lilies from areas around docks and beaches.

Drawbacks The technique is time-consuming and can be costly, especially where contract divers are used. Diver visibility may become obscured by turbidity generated by swimming and digging activities. Also, it may be difficult for the laborer to see and dig out all plant roots. Environmental impacts are limited to mostly short-term and localized turbidity increases in the overlying water and some bottom disruption.

Costs Costs will vary depending on whether contract divers or laborers are used, or if removal activities are the result of volunteer efforts. In the case of contract divers and dive tenders, expenses can run upward of $500 to $2400/day with area covered dependent on height and density of plants.

Permits No State permits are currently required for hand-pulling aquatic plants. However, local (King County) shoreline permits may be required.

Hand-Cutting

Principle This technique is also a manual method, but differs from hand-digging in that plants are cut below the water surface (roots generally not removed). Because roots are not removed, this is a less intensive removal technique. Implements used include scythes, rakes, or other specialized devices that can be pulled through the weed beds from shoreline or dock or by boat. Mechanized weed cutters are also available that can be operated from the surface for small-scale control.

Control Effectiveness and Duration Root systems and lower stems are often left intact. As a result, effectiveness is usually short-term as regrowth is possible from the uncut root masses. Duration of control is limited to the time it takes the plant to grow to the surface.

Advantages The technique results in immediate removal of nuisance submerged plant growth. Costs can be minimal.

Drawbacks Like hand-pulling, the technique is time-consuming. Visibility may become obscured by turbidity generated by cutting activities. Also, since the entire plant is usually not removed, this technique does not result in long-term reductions in growth. Environmental impacts are limited to mostly short-term and localized turbidity increases in the overlying water and some bottom disruption. Cut plants must be removed from the water.

Costs Where volunteer efforts are employed, costs are mostly limited to purchase of a cutting implement. This can vary from under $200 for the Aqua Weed Cutter (Sunrise Corp.) to over $1000 for the mechanized Swordfish (Redwing Products).

Permits No permits are required for hand-cutting or raking of aquatic plants. Mechanical cutting (including battery-operated equipment) does require hydraulic approval by Washington Department of Fish and Wildlife. It is advisable to check with the local jurisdiction (e.g. King County) before beginning any aquatic plant- cutting activities.

Bottom Barrier Application (Sediment Covers)

Principle Barrier material is applied over the lake bottom to prevent plants from growing up through the water column. Bottom covering materials such as sand-gravel, polyethylene, polypropylene, synthetic rubber, burlap, fiberglass screens, woven polyester, and nylon film have all been used with varying degrees of success. Applications can be made up to any depth, with divers often utilized for deeper water treatments. Usually bottom conditions (presence of rocks or debris) do not impede most barrier applications, although pre-treatment clearing of the site is often useful.

Control Effectiveness and Duration Bottom barriers can provide immediate removal of nuisance plant conditions upon placement. Duration of control is dependent on a variety of factors, including type of material used, application techniques, and sediment composition. Elimination of nuisance plant conditions for at least the season of application has been demonstrated by synthetic materials like Aquascreen and Texel. Where short-term control is desired for the least expense, burlap has been found to provide up to 2-3 years of relief from problematic growth before eventually decomposing (Truelson, 1985; 1989). After satisfactory control has been achieved (usually several months), some barrier materials can be relocated to other areas to increase benefits.

Advantages Bottom barriers can usually be easily applied to small, confined areas such as around docks, moorages or beaches. They can be hidden from view and do not interfere with shoreline use. Bottom barriers do not result in significant production of plant fragments (critical for milfoil treatment). Bottom barriers are most appropriately used for localized, small-scale control where exclusion of all plants is desirable; where other control

technologies cannot be used; and where intensive control is required regardless of cost.

Drawbacks Depending on the material, major drawbacks to the application of bottom barriers include some or all of the following: high materials cost, labor-intensive installation, limited material durability, possible suspension due to water movements or gas accumulation beneath covers, or regrowth of plants from above or below the material. Periodic maintenance of bottom barrier materials is required to remove accumulations of silt and any rooting fragments. In some situations, removal and relocation of barriers may not be possible (e.g., natural fiber burlap does decompose over time). Sediment covers can also produce localized depression in populations of bottom-dwelling organisms like aquatic insects.

Costs Costs vary from approximately $0.30/sq. ft (Texel) to $0.35/sq. ft (Aquascreen) for materials with an additional $0.25-0.50/sq. ft for installation. Locally, prices for rolled burlap material (available in fabric stores, outlets) average from $0.15 to $0.25/sq. ft for materials only.

Permits Bottom barrier applications require hydraulic approval from Washington Department of Fish and Wildlife (no charge). current King County Code should be consulted regarding aquatic plant control activities and any required shoreline permits for bottom barrier use.

TABLE H-1.
SUMMARY OF AQUATIC PLANT MANAGEMENT TECHNIQUES AVAILABLE IN WASHINGTON STATE
(Adapted from Gibbons et. al., 1994)

Method	Appropriate Scale (area or extent)	Duration of Control	Intensity of Control	Cost	Advantages	Disadvantages	Permit(s) Required?
Physical							
Hand-pulling	Small-scale	Season or longer	Moderate to High (with complete removal)	$0 with volunteer labor $500 to $2400/day for contract divers	• Site specific • Species specific • Minimum impact on native plants • Use near obstructions	• Slow, labor intensive, expensive • short-term turbidity increase • Diver visibility can restrict effectiveness	Maybe
Hand-cutting	Small-scale	< One season	Moderate	$100 to $1000 for equipment + labor	• Immediate plant removal	• Slow • Fragments generated • Short-term increase in turbidity	Yes
Bottom Barriers	Small-scale	2 to 3 years	High	$0.15 to $0.75/sq. ft. for material $0.25 to $0.50/sq. ft. for installation	• Immediate plant removal • Materials reusable • Site specific • Useful around obstructions	• Not species specific • Benthic organism impacts • Material costs • Maintenance required	Yes
Drawdown	Large-scale	None	Low	Variable	• Useful for repair/ maintenance of shorelines and structures • May enhance growth of emergents (waterfowl habitat)	• Not species specific • May impact wetlands • Loss of recreation • Dissolved oxygen decrease • Benthic invertebrate impacts	Yes
Watershed Controls	Small-scale	None - long-term	Low	Low-mod	• Long-term improvement in water quality • May encourage rooted and discourage non-rooted species	• Does not address nutrient sources used by most aquatic plants • May encourage rooted/discourage non-rooted species •Sometimes difficult to implement	No

SUMMARY OF AQUATIC PLANT MANAGEMENT TECHNIQUES AVAILABLE IN WASHINGTON STATE (Continued)

Method	Appropriate Scale (area or extent)	Duration of Control	Intensity of Control	Cost	Advantages	Disadvantages	Permit(s) Required?
Water column dye	Weeks to months	Weeks to months	Low	$12.50/acre-ft.	• Non-toxic • No special equipment needed • Colors water blue	• Shallow, closed systems only • Repeat treatments through growing season required • Not effective when plants near surface • No use in potable, flowing, or chlorinated water • Some classified as herbicides	Yes/No (Those classified as herbicides require a permit)
Mechanical							
Harvesting	Large-scale	Less than one season	Low-Mod	$600/acre (May vary with transport costs)	• Immediate plant removal to cutting depth (4 to 8 ft.) • Minimal bottom disturbance • Materials may be composted • Reduces internal loading of nutrients	• Plant disposal • Fragments produced • Fish and invertebrate impacts • Slow • High initial capital $ • Operating depth limited • Operations depend on weather • Not species specific	Yes
Rotovation/ Cultivation	Large-scale	2 to 3 years	Mod-High	$1000 to $1700/acre (depends on plant density and area of treatment)	• Winter treatment minimizes summer season recreation impacts • May increase species diversity	• Bottom disturbance /increased turbidity • Long-term efficacy only on perennials • Bottom obstructions limit use • Not species specific	Yes
Hydraulic dredge	Large-scale	Potentially long	High	variable, average $2-$7/m3	• Removal of entire plant, including roots • Additional benefits of deepening lake, removal or enriched or toxic sediments	• Very costly • Temporary bottom disturbance and increased turbidity in water column • Not species specific, where mixed comm	Yes

SUMMARY OF AQUATIC PLANT MANAGEMENT TECHNIQUES AVAILABLE IN WASHINGTON (Continued)

Method	Appropriate Scale (area or extent)	Duration of Control	Intensity of Control	Cost	Advantages	Disadvantages	Permit (s) Required?
Diver-operated dredge	Small-scale	Potentially long (Depends on availability of propagules for recolonization)	Mod-High	$1100-2000/day (coverage depends on plant density)	• Site specific • Species specific • No depth constraints • Used near obstacles	• Labor intensive • Slow • Potential fragment production • Temporary bottom disturbance and increased turbidity	Yes
Biological							
Grass carp	Large-scale	Potentially long	Low-High	$50 to $200/acre (depending on stocking density)	• Low maintenance • Large area covered • Triploid fish are sterile	• Stocking densities not well established • Difficult to fine-tune control • Preference for native species over exotics • Containment structures required • Ecological impacts not fully known • Not site specific • Recapture problems • Susceptible to predation by wildlife or humans	Yes
Chemical							
Fluridone	Large-scale	> 1 year (depends on availability of propagules for recolonization)	High	$700 to $1000/acre	• Systemic herbicide • Some species specificity with correct application rates • Non-toxic	• Requires long contact time • Off-site movement possible • Nutrient release and dissolved oxygen	Yes
Glyphosate	Large-scale	> 1 year (depends on availability of propagules for recolonization)	High	$250/acre	• Systemic herbicide • Non-toxic • No label restrictions on swimming and fishing	• Non-selective herbicide • Emergent plants only	Yes
Endothall	Large-scale	Weeks to months	Moderate	$500 to $700/acre	• Short contact time required • Low toxicity • Low cost • Fast dissipation	• Contact herbicide • Temporary effect • Some label restrictions for swimming and domestic water use	Yes

Lake Twelve Aquatic Plant Control Intensity Zones
Step I

Extent of Aquatic Plant Problem in Lake Twelve

Two critical components of the integrated management approach involve assessing the **extent** of the problem and **intensity** of corrective action needed. Two types of weed species have been identified as targets for control in Lake Twelve: ***Eurasian watermilfoil and waterlilies***. Eurasian watermilfoil (*Myriophyllum spicatum* L.) is classified by the State of Washington as a Class B Noxious Weed. For infestations of Eurasian watermilfoil, any level of occupancy necessitates control action, given the considerable nuisance potential of the plant if growth is left unchecked. Furthermore, this is entirely consistent with Washington State objectives concerning noxious weed species, which gives high treatment priority to prevention, control and eradication of these invaders from state waters (WDOE, 1992). In order to achieve this end in a specific waterbody, more intensive, aggressive measures may be justified with the necessary precautions. Other major nuisance plants in Lake Twelve are species of waterlily (*Nymphaea*), which are also not native to the Pacific Northwest region. Because of human safety and navigational problems associated with dense growth of waterlilies around the shoreline, but especially offshore of the State boat launch, aggressive control measures are also appropriate for use against these macrophytes.

A critical part of IAPMP development is determining important plant zones in Lake Twelve and what degree of control should be applied to each of those zones. To reiterate, the ***goal of aquatic plant management is not to remove all vegetation from a waterbody, but to selectively eliminate harmful or noxious plant populations while adequately preserving native stands***. As a result, macrophyte control decisions can range from leaving select high quality plant beds intact (*no control action*) to implementing aggressive removal measures against noxious or nuisance plant stands (*high level of control*), being careful to minimize impacts to beneficial native species. Development of a ***Control Intensity Map*** provides a useful aid for choosing appropriate treatment options for each area of the lake (See Step J).

Highest Intensity Control

Figure I-1 is a Control Intensity Map for Lake Twelve that clearly shows three different macrophyte control intensity zones. The highest priority zone is that area between the 1 and 4 m depth contours inhabited by the noxious, exotic weed Eurasian watermilfoil. Currently, milfoil beds in Lake Twelve occur in moderate densities, but the growth habit is such that much of the plant biomass is concentrated in the upper water column. This situation creates a real physical obstacle to movement through the lake by means of rowing or motoring. The presence of this noxious

weed in the lake justifies use of ***high intensity control*** efforts to remove plant populations.

Moderate to High Intensity

The plant zone between shoreline and the 3.25 m (10.5 ft) depth is occupied by surfacing waterlilies and watershield, that, depending on location in the lake, necessitate moderate to high intensity control efforts. High levels of control involving maximal removal of plants can be applied to those areas where, for safety or navigation reasons, minimal or no surfacing plants can be tolerated. Potential areas would include shoreline adjacent to the state boat launch, popular swimming spots, and dock areas. Other areas of the lake may be subjected to a lesser control effort such as selective spot treatment of water lily beds.

No Control

Aquatic plant management recognizes the importance of maintaining a healthy, diverse plant community for human and wildlife utilization. As a result, beneficial native plant stands or special habitat areas in a lake are not targeted for any direct action, but are left untouched. In Lake Twelve, two areas have been identified as no control zones. The largest zone is the open water mid section of the lake, greater than 4.5 m (14.75 ft) in depth. The zone is primarily inhabited by sparse stands of pondweed (*Potamogeton* sp.) and macroalgae (*Nitella* spp.), the latter providing a source of competition to planktonic algae in the lake. Plant growth in this deeper region of the lake is currently not and should not be problematic with implementation of a prudent macrophyte management plan. The other zone is the littoral area from lake bank (approximately 300 m shoreline length) out to 1 meter depth that is directly adjacent to the east end wetland and outlet. The intent of creating this zone is to provide a protective in-lake vegetative buffer to the wetland, which can serve as a type of mitigation to potential effects of certain aquatic plant treatment methods that may be employed. In addition, since waterlilies do provide beneficial forage, nesting and refuge sites in the lake, pockets of lilies can be left around the lake littoral where they would not interfere significantly with human uses.

Prudent application of the various control intensity strategies within Lake Twelve should ultimately result in selective removal of nuisance plant populations, while retaining diverse and abundant native plant stands throughout the lake.

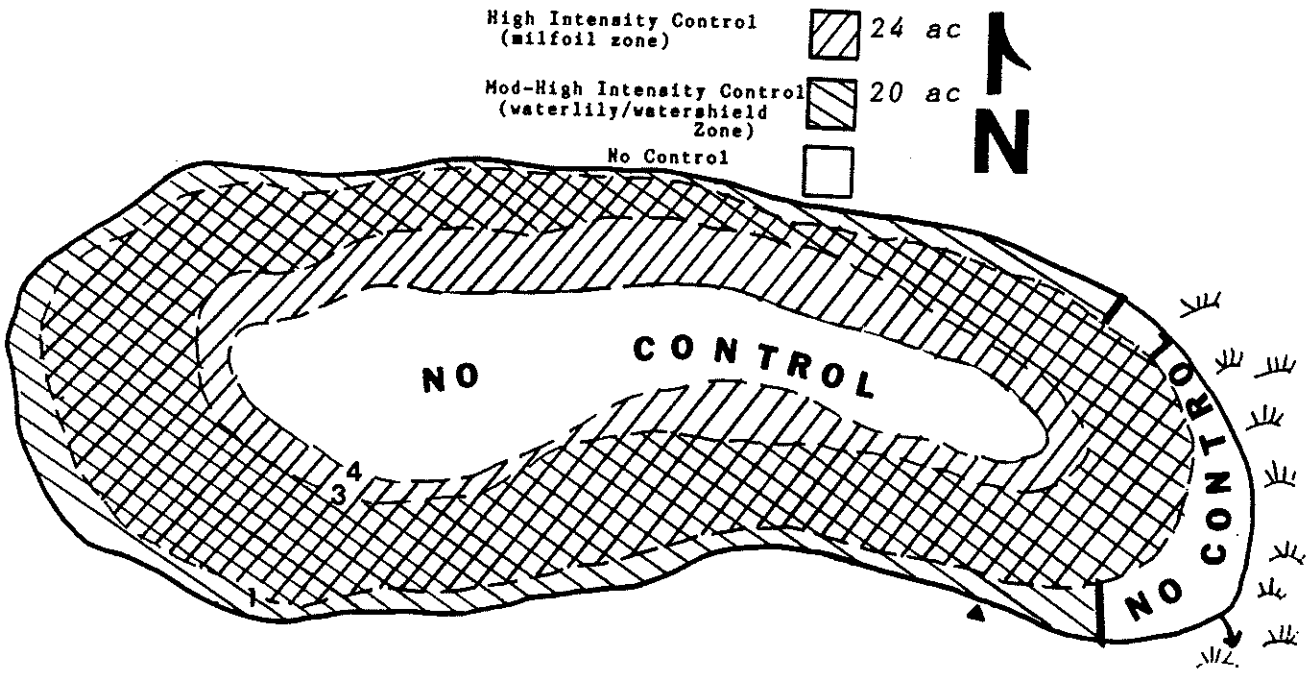

Figure I-1. Aquatic Plant Control Intensity Map for Lake Twelve. Depth Contours Shown in Meters.

Alternative Integrated Treatment Scenarios For Lake Twelve
Step J

This section presents alternative in-lake treatment scenarios for management of nuisance aquatic plant populations in Lake Twelve. At this point, it may be helpful to explain the various types of management strategies available as action alternatives, particularly with regard to Lake Twelve.

Management Strategies Span the Spectrum

Aquatic plant management strategies span the control spectrum, ranging from **aggressive removal (high intensity control)** of noxious plant populations from the waterbody (e.g., Eurasian watermilfoil) to less intensive **maintenance (cosmetic)** techniques that aim to achieve short-term decreases in nuisance macrophyte growth Bounded by these two endpoints, management strategies vary in intensity of treatment depending on types of problem plant(s), extent of infestation and program goals.

A Balancing Act

It is important to note that benefits of any management program cannot be gained without some short-term adverse impacts, as there is no ideal management alternative that is 100% effective against target species, totally environmentally safe, and cost-effective. The decision-making process regarding design of a specific aquatic plant management program necessitates weighing all factors and achieving a balance between acceptable environmental disruption and cost-effective treatment and a consensus among all affected parties on course of action.

Realistic Expectations Regarding Milfoil Removal

Effective treatment of milfoil populations in Lake Twelve will require aggressive, lakewide action, using intensive techniques that kill or remove the entire milfoil plant, including roots and upper stems. In contrast, if less intensive control strategies were implemented or no action was taken at all, the lake would continue to support milfoil populations and remain a source of fragments that could be transported to other area lakes. To be sure, elimination of Eurasian watermilfoil from a waterbody is an uncertain process, and is very dependent on age and extent of infestation. Certainly, the chances for successful removal of this weed from a lake are greater and costs are less when the infestation is in a beginning, pioneering stage than when the plant becomes well-established throughout a waterbody as it has in Lake Twelve. Given the present extent of Eurasian watermilfoil growth throughout Lake Twelve, complete removal of this plant may be a difficult task to achieve at best and will require a continuous, intensive, long-term effort to even come close.

Other Management Issues

While the need to use intensive control techniques in Lake Twelve is clear, **choice** of methods and operational **logistics** are necessarily tied to milfoil and waterlily growth patterns in Lake Twelve. The band of milfoil growth in Lake Twelve at this time

occurs primarily at depths of between 1.5 and 14 feet. The fact that milfoil occurs in the shallows intermingled with other plants like waterlilies, also targeted for control, complicates the control strategy somewhat. Furthermore, as waterlily beds do extend right from the lake bank, management efforts must be prudently applied to maintain stability of the rather flocculent littoral sediments. Finally, it will be important to maximize protection of native aquatic vegetation and wetland fringe plants at the eastern end of the lake. Thus, a combination of control alternatives will be necessary, differentially targeting milfoil and waterlily areas both in time and space, perhaps resulting in some overlap of areas covered.

Options Narrowed

As described earlier, truly effective milfoil and waterlily control alternatives must either kill the roots/shoots or physically remove the entire plant from the sediment. This requirement tends to narrow down prospective treatment options for Lake Twelve. Intensive control methods that can be effectively used against Eurasian watermilfoil and waterlilies include **hydraulic dredging, hand removal, bottom barrier application, application of systemic aquatic herbicides, or implantation of sterile grass carp**. None of these is without some potential damage to non-target aquatic animals and plants. However, timely and careful use of such intensive control tactics should minimize impacts to non-target organisms in the long-term.

Proposed Treatment Scenarios for Lake Twelve

In Lake Twelve, an **integrated** aquatic plant management program using a **combination of in-lake physical/mechanical,, physical/chemical or physical/biological techniques** listed above will be more effective in meeting a management goal of aggressive removal of milfoil and waterlilies. In other words, a long-term, integrated program extending over at least 5 years is highly recommended that incorporates a major mechanical, chemical or biological treatment coupled with bottom barrier application and hand removal, a public education/exotic weed prevention program, and a monitoring/evaluation component.

In view of this multi-faceted objective, the following milfoil/ waterlily treatment options for Lake Twelve are presented in descending order of intensity of treatment and effectiveness against target plants. Of note is that the most intensive actions may possibly have the greatest initial impacts on the ecosystem and require the greatest initial expense. Thus, the order in which the scenarios are presented does not represent a preferred ranking. All of the treatment scenarios are set up in terms of an integrated aquatic plant management program with review each year, utilizing a main, large-scale treatment option, supported by other smaller scale options. The long-term, integrated milfoil/waterlily management program is composed of a reactive treatment component, consisting of a combination of large-scale and small-scale methods, a proactive public awareness/preventative component, and a monitoring/evaluation element. For Lake Twelve, none of the recommended options is expected to have any detrimental impacts on human health, if treatments are performed

properly. Table J-1 summarizes Proposed Management Options, including Integrated Treatment Scenario components and projected costs for a minimum 5-year program.

Treatment Scenario #1

In-lake Treatments (All treatments contracted out)

Major treatment of milfoil/waterlily beds using hydraulic dredging of substrate to a depth of 2 m between the 2m and 4m depth contours,

Upland disposal of sediment/plant fragment spoils

Minor treatment of undredged shallow shoreline using other physical means (hand pulling/bottom barrier application)

Minor treatment of undredged shallow shoreline waterlily areas with systemic Rodeo

Other Program Elements

Permit Application/Environmental Assessment, if necessary

Public Awareness-Prevention Program

- **Public meetings/posted signs on lake/ newsletters/media coverage**
- **Citizen watch for milfoil in lake**
- **Boat/Trailer Inspections-voluntary**

Program Monitoring and Effectiveness Evaluation

Scenario #1 is the most intensive of milfoil treatment scenarios with the objective of removing 2 meters of sediment from between the 2m to 4m depth contours of the lake system over a total of 20 acres of bottom area. Because of the flocculent nature of the lake sediments, nearshore milfoil and waterlily areas are treated with more localized methods (hand-pulling, bottom barrier, herbicide RODEO®) to protect shoreline stability. All mechanical and chemical treatments are contracted out.

Years 2+: Control efforts in the second year should consist of spot treatment of regrowth by applying bottom barrier or herbicide treatment (RODEO®) of waterlilies. In addition, hand removal is also recommended for small patches of milfoil discovered during the course of the year. Milfoil prevention efforts and public outreach activities are continued. Annual monitoring of treatment effectiveness is highly recommended in order to make any needed adjustments in the succeeding year's management program.

First year costs for initial hydraulic dredge treatment with upland disposal of sediment/milfoil spoils will most likely be the most costly of options and may become the real deciding factor on intensity of program. But, with this scenario, the bulk of aquatic plant management program costs should be concentrated in this first year of treatment. At an average cost for hydraulic dredging (not including disposal) by private diving contractor of roughly $8/m3, a single treatment covering 20 shoreline acres of Lake Twelve could cost as much as $1.3 million. Materials and labor costs for upland (lakeshore) disposal of dredged slurry would depend on type and quantity of hoses/pipes/equipment,

availability and proximity of disposal sites; disposal costs could add upwards of $13,000 to $130,000 or more depending on distance to disposal site. In those lake areas not treatable by primary method of hydraulic dredging, additional materials and wage costs would be incurred as a result of diver application of bottom barrier and/or hand removal of milfoil/waterlily plants; commercial diver rates range from $1500 to $2000/day including tender. Certainly, much of the expense of hiring private diving contractors, for example, to apply bottom barriers could be offset by applying dive-certified volunteers to these jobs. The community should investigate whether using its own dive personnel would result in significant increase in insurance/liability expense. It is anticipated that the prevention/public awareness component would be mainly a volunteer effort, with negligible expenses (estimate $500/year). Finally, monitoring costs for a private consultant to evaluate carry-over treatment effectiveness in the lake are estimated to be around $1500-3000. Total costs could range from **$1.396 to 1.513 million** for the first year of full-scale intensive milfoil/waterlily treatment using hydraulic dredging/removal as the major treatment.

Costs: Year 2+: Depending on the completeness of milfoil/waterlily removal by the first year's mechanical/physical treatments and success of the milfoil prevention program, regrowth should be significantly less. Thus, total intensive control effort/cost should be correspondingly less. In succeeding years following these intensive treatments, annual program costs should decline and eventually approach a minimum maintenance level of less than $30,000. It may be necessary for the Lake Twelve community to internally fund all or part of macrophyte control programs in the lake. However, other external sources of money may be available, such as through the active State Revolving Fund (low-cost loans) or State Aquatic Weed Management Fund (matching grants).

Ecological/human impacts: Of the combined treatment options presented for Lake Twelve, the potential for **disturbance of non-target plants and animals** is greatest with this scenario due to the physical removal of large volumes of substrate. However, because removal efforts are only being applied to a partial area of lake bottom (zone between 2 and 4 meter depths), detrimental effects on organisms can be kept to a minimum. Also, benthic organisms inhabiting areas beneath bottom screening may be adversely impacted, but effects would be limited to the small area of coverage and would be short-term, especially if barriers were removed and relocated. Proper application of the systemic herbicide RODEO can maximize selectivity for waterlilies and keep impacts on non-target plants to a minimum. Because control efforts will be confined to water depths of between 1-4 meters where milfoil growth is concentrated, there should be negligible to no effect on wetland fringe plants. No unique species will be impacted by these operations as a check of the Washington Wildlife and Natural Heritage Program data bases produced no

listing of rare or sensitive plant/animal species directly in Lake Twelve (Appendix B).

Water quality effects of hydraulic dredging can also be kept to a minimum. There may be some short-term increases in turbidity in the area of operation, but these should be limited due to relatively small area of treatment. Deployment of silt screens around the active area of treatment can also help keep turbidity increases contained. It is not expected that diver hand digging or application of bottom barrier should impact lake water quality outside of some short-term turbidity increases as a result of diver activity near lake bottom. It is recommended that critical areas of lake bottom (contaminated or high nutrient content, such as near storm water outfalls) be identified prior to treatment in order to avoid possible impacts to these sites.

There may be some short-term interference with **recreational pursuits** in the lake during time of dredging operations, herbicide application or bottom barrier applications due to the need for isolating treatment areas from lake users to carry out work. Again, interference with lake usage could be minimized by conducting operations early in the season (e.g., April-June) and on weekdays. Once the operations were completed, there would be no restrictions to use.

Permits/Special Requirements

Hydraulic permit required for hydraulic dredging in lake, obtainable (free of charge) from Washington Department of Fish and Wildlife (WDFW).
Hydraulic permit required for bottom screening in lake, obtainable (free of charge) from WDFW.
Application of bottom barrier and aquatic herbicides may be subject to Shoreline Management Act and may need Shoreline permit; permit cost for either method is dependent on total cost of treatment.
It may be necessary to obtain a letter of approval from Washington State Department of Natural Resources.
Use of aquatic herbicides does require submitting an Aquatic Plant Management Permit Application for short-term modification to state water quality standards to Washington State Department of Ecology before initiation of treatment.

Ideally, time required for state agencies to process a permit application is at least 45 days, but could be much longer if the permit application is not properly completed. If multiple permits from several local, county or state jurisdictions are required, the overall processing time period could be extended as well.

Treatment Scenario #2

In-lake Treatments (Most treatments conducted by lake volunteers)
Lease/purchase of hydraulic dredge equipment
Major treatment of milfoil/waterlily beds using hydraulic dredging of substrate to a depth of 2 m between the 2m and 4m depth contours,
Upland disposal of sediment/plant fragment spoils
Minor treatment of undredged shallow shoreline using other physical means (hand pulling/bottom barrier application)
Minor treatment of undredged shallow shoreline waterlily areas with systemic Rodeo (contracted out)
Other Program Elements
Permit Application/Environmental Assessment, if necessary
Public Awareness-Prevention Program

- **Public meetings/posted signs on lake/ newsletters/media coverage**
- **Citizen watch for milfoil in lake**
- **Boat/Trailer Inspections-voluntary**

Program Monitoring and Effectiveness Evaluation.

This treatment scenario is also very intensive, consisting of the same major components as #1 with the objective of removal of milfoil and waterlilies from priority areas of the lake, but differs in the amount of work that is contracted to independent vendors. The Public Awareness element should be ongoing year-round, with most of the volunteer effort concentrated during typical high-use period (e.g., April-October). The monitoring element consists of evaluation of effectiveness of program and provision for modification in plan, if needed. This element would become active during the latter part of the control program year (e.g., July-December).

Years 2+: Same as in Scenario #1.

First year costs for initial hydraulic dredge treatment with upland disposal of sediment/milfoil spoils will be less than scenario #1 mainly because the 20 acre dredge treatment will be spread over 5 years. This scenario includes purchase of a hydraulic dredge unit for an estimated $80,000 that is owned and operated by lake volunteers. A major assumption involved with this scenario is operation of the dredge at a total yearly treatment rate of 4 acres/year (=40 m^3/hr for 100 days operation/year). Same costs for operation @ $8/$m^3$ are also assumed, with similar additional costs for upland disposal of $13,000-130,000, and expenses incurred for any required environmental assessment and permitting. In those lake areas not treatable by primary method of hydraulic dredging, additional materials and wage costs would be incurred as a result of diver application of bottom barrier and/or hand removal of milfoil/waterlily plants; commercial diver rates range from $1500 to $2000/day including tender. Certainly, much of the expense of hiring private diving contractors, for example, to apply bottom barrier could be offset by applying dive-certified volunteers to these jobs. The community should investigate

whether using its own dive personnel would result in significant increase in insurance/liability expense. It is anticipated that the prevention/public awareness component would be mainly a volunteer effort, with negligible expenses (estimate $500/year). Finally, monitoring costs for a private consultant to evaluate carry-over treatment effectiveness in the lake are estimated to be around $1500-3000. Total costs could range from **$395,600 to $419,000 for the first year** of full-scale intensive milfoil/waterlily treatment using hydraulic dredging/removal as the major treatment.

Costs: Year 2+: Assuming each year's dredging effort is maximal, total annual costs in the second and successive years should be under $300,000.

Ecological/human impacts: Like scenario #1, the potential for **disturbance of non-target plants and animals** is great due to the physical removal of large volumes of substrate. However, because annual removal efforts are being applied to an even smaller area than that in scenario #1, detrimental effects on organisms can be kept to a minimum. Also, benthic organisms inhabiting areas beneath bottom screening may be adversely impacted, but effects would be limited to the small area of coverage and would be short-term, especially if barriers were removed and relocated. Proper application of the systemic herbicide Rodeo can maximize selectivity for waterlilies and keep impacts on non-target plants to a minimum. Because control efforts will be confined to water depths of between 1-4 meters where milfoil growth is concentrated, there should be negligible to no effect on wetland fringe plants. No unique species will be impacted by these operations as a check of the Washington Wildlife and Natural Heritage Program data bases produced no listing of rare or sensitive plant/animal species in Lake Twelve proper (Appendix B).

As in the previous scenario, **water quality effects** of hydraulic dredging can also be kept to a minimum. There may be some short-term increases in turbidity in the area of operation, but these should be limited due to relatively small area of treatment. Deployment of silt screens around the active area of treatment can also help keep turbidity increases contained. It is not expected that diver hand digging or application of bottom barrier should impact lake water quality outside of some short-term turbidity increases as a result of diver activity near lake bottom. It is recommended that critical areas of lake bottom (contaminated or high nutrient content, such as near storm water outfalls) be identified prior to treatment in order to avoid possible impacts to these sites.

There may be some short-term interference with **recreational pursuits** in the lake during time of dredging operations, herbicide application or bottom barrier applications due to the need to isolate treatment area from lake users for performance of work. Again, interference with lake usage could be minimized by

conducting operations early in the season (e.g., April-June) and on weekdays. Once the operations were completed, there would be no restrictions to use.

Permits/Special Requirements

Hydraulic permit required for hydraulic dredging in lake, obtainable (free of charge) from Washington State Department of Fish and Wildlife (WDFW).
Hydraulic permit required for bottom screening in lake, obtainable (free of charge) from WDFW.
Application of bottom barrier or aquatic herbicides may be subject to Shoreline Management Act and may need Shoreline permit; permit cost dependent on total treatment costs.
It may be necessary to obtain a letter of approval from Washington State Department of Natural Resources.
Use of aquatic herbicides does require submitting an Aquatic Plant Management Permit Application for short-term modification to state water quality standards to Washington State Department of Ecology before initiation of treatment.

Ideally, time required for state agencies to process a permit application is at least 45 days, but could be much longer if the permit application is not properly completed. If multiple permits from several local, county or state jurisdictions are required, the overall processing time period could be extended as well.

Treatment Scenario #3

In-lake Treatments

Whole-lake (littoral) diver surveillance for milfoil
(Year 1) **Major treatment using SONAR, one annual application along entire lake littoral**
(Year 2)Major treatment using RODEO, one annual application at selected areas along lake littoral
Minor treatments using hand removal and bottom barrier

Other Program Elements

Public Awareness-Prevention Program.

- **Public meetings/posted signs on lake/ newsletters/media coverage**
- **Citizen watch for milfoil in lake**
- **Boat/Trailer Inspections-voluntary**

Program Monitoring and Effectiveness Evaluation.

The major treatment component of this scenario consists of an intensive, chemical treatment using ***systemic herbicides*** that are actively absorbed by plant roots and shoots. Two different herbicides, SONAR and RODEO, are used that differentially target watermilfoil and waterlilies, respectively. In **year 1**, an initial survey of the lake littoral is conducted by diver sometime in spring (e.g., March or April) to locate milfoil plants and determine extent of coverage in lake. Upon completion of diver survey, control elements can be initiated, ideally early in the milfoil growth season (May to July). In this scenario a large-scale application of SONAR (fluridone) is made along the entire shoreline of Lake Twelve during the spring season following the diver survey to confirm extent of milfoil growth. Application would be made in a

narrow band covering lake surface between 1 and 4 meter water depth (where milfoil growth was concentrated as of July 1994), approximately 24 acres total.

Year 2+: As in Year 1, an early season, pre-treatment diver inspection of the lake littoral is recommended. Depending on the effectiveness of milfoil removal in Lake Twelve following the first year SONAR treatment, another SONAR application may be necessary in the following year to hit regrowth. Block applications of SONAR possibly covering up to 10 acres may be needed in year 2. Treatment of selected waterlily beds with aquatic herbicide RODEO is delayed to year 2 in order to assess extent of non-target impacts on the lilies by first-year SONAR application. In late spring-early summer of year 2, when waterlily growth is more apparent, application of RODEO is made along priority shoreline areas between 1m and 3.25 m depth (up to 5 acres), but avoiding the buffer area less than 1 m depth abutting the east end wetland. Because at least two herbicide treatments are anticipated, mitigation efforts (to revegetate any damaged shoreline fringe areas) are delayed to year three to allow time for full effects to become obvious. Later in the season of year two, when evidence of kill effectiveness is more apparent (2-3 months later), cleanup treatment of unaffected milfoil plants by hand removal or bottom screening application may be necessary. In succeeding years, hand removal of small milfoil patches is recommended, as well as maintenance and reapplication of bottom barriers, if needed. Small, spot treatment of waterlily beds may be necessary in year 4 (up to 2.5 acres). The prevention program (boat checks, public education) should be continued. Monitoring of treatment effectiveness should also be continued in order to make appropriate adjustments in succeeding year's management program.

First Year Costs: Cost for use of private divers (for pre-treatment survey, milfoil removal, bottom barrier application) range upwards of $1500 to $2000/day. At an average cost for materials and application by private contractor of roughly $1000/acre, first year costs for an application of SONAR (25 acres) could be upwards of $25,000. It is anticipated that the prevention component would be mainly a volunteer effort, with negligible expenses. Shoreline permit fees could cost upwards of $2500. Monitoring costs for a private consultant to monitor carry-over effectiveness in the lake are estimated to be $3,000. Thus, first year program costs could be as much as **$33,600**, assuming at least 1 day for diver services and materials expenses.

Costs for Year 2+: The bulk of program costs for scenario 3 will most likely occur in year 2 ($40,800). This is because of a possible need for additional SONAR retreatment, a RODEO application, and diver hand removal/bottom barrier application, all depending on efficacy of the first year herbicide treatments. At an average cost of $250/acre, a 5 acre application of RODEO would cost approximately $1300. As in year 1, shoreline permit fees could cost upwards of $2500. Total annual costs for an

herbicide-based program for milfoil/waterlily control in Lake Twelve using SONAR/ RODEO and supported by physical removal methods using a diver should successively decline after the second year, approaching costs of **$33,000 or less**. The main cost in the latter years will most likely be purchase and installation of new bottom barrier material. Mitigation efforts are delayed to the third year to allow time to estimate revegetation needs resulting from any herbicide damage to wetland fringe plants. Based on results of similar herbicide programs in Washington State, emergent plant revegetation cost should be minimal; for example, if 300 m^2 of shoreline area were affected, revegetation estimates would be about $2,500 relying largely on volunteer labor.

Ecological/human impacts: Because of potential for drift, SONAR may not stay within the treatment zone, resulting in extension of effective treatment area to as much as two times the application area. However, detrimental impacts of both SONAR and RODEO on other vulnerable non-target in-lake plants can be minimized by adjusting timing and rate of application to target milfoil/waterlilies at their most susceptible point. The possibility does exist for some downstream effects of SONAR on the wetland at the east end of the lake, but because of dilution effects, these impacts should be minimal. Also, delaying the SONAR treatment to late spring-early summer, when precipitation and outflow decline substantially, should further minimize downstream movement of the herbicide. Considering this potential for non-target plant effects, a plan for mitigation of shoreline and wetland plants may be necessary.

Fluridone has a very low order of toxicity to fish and wildlife, and at the extremely low concentrations expected to be used in Lake Twelve, should have negligible effect on trout and other warmwater fish in Lake Twelve, and any salmonids present downstream if flow through the wetland even exists. With an even lower order of toxicity to fish and wildlife, glyphosate impacts should also be absolutely minimal, more so since the herbicide is hand-applied to individual leaf surfaces.

There are no expected risks to human health if Lake Twelve is treated with SONAR. A chemical review of SONAR literature was recently completed by Thurston County Public Health and Social Services Department with regard to usage in Long Lake, which found no significant long-term human health risks associated with the proper use of this herbicide (Thurston County Public Health and Social Services Department Memo, SONAR Review, March 27, 1990).

Water quality impacts of phased SONAR and RODEO applications should be minimal. Toxicity effects of fluridone on vegetation are slow, taking up to 1-3 months to become visually evident. The process of plant death is slow, so potential nutrient releases and possible algal bloom should be correspondingly slowed too. If non-target plants are not substantially damaged by

the SONAR treatment, unimpacted plants could continue to take up the extra nutrients, providing a mechanism for natural mitigation and perhaps staving off an artificially-induced algal bloom.

There may be some recreational impacts, affecting mostly swimming, which is discouraged during and immediately after treatment, although there is no label restriction for swimming (See SONAR label, Appendix D). There are irrigation restrictions with SONAR use. Glyphosate treatment does carry a label restriction on use when applied within 1/2 mile of potable intakes, requiring a shutoff on all such intakes for a minimum of 48 hours or until glyphosate levels drop below 0.7 ppm.

Permits/Special Requirements

Use of aquatic herbicides does require submitting an Aquatic Plant Management Permit Application for short-term modification to state water quality standards to Washington State Department of Ecology before initiation of treatment.
Hydraulic permit required for bottom screening in lake, obtainable (free of charge) from Washington State Department of Fish and Wildlife (WDFW).
Bottom barrier application and herbicide treatment may be subject to Shoreline Management Act and may need Shoreline permit for installation, dependent on scale and total cost of in-lake treatment.

Ideally, time required for state agencies to process a permit application is at least 45 days, but could be much longer if the permit application is not properly completed. If multiple permits from several local, county or state jurisdictions are required, the overall processing time period could be extended as well.

Treatment Scenario #4

In-lake Treatments

Major treatment involving planting of sterile grass carp
Outlet containment structure design and modification
Minor treatments using hand removal and bottom barrier

Other Program Elements

Environmental permits and assessment, if necessary
Public Awareness-Prevention Program.

- **Public meetings/posted signs on lake/ newsletters/media coverage**
- **Citizen watch for milfoil in lake**
- **Boat/Trailer Inspections-voluntary**

Program Monitoring and Effectiveness Evaluation.

This scenario involves implantation of sterile grass carp as a potential technique for lake-wide, moderate-intensity control of submersed plants in Lake Twelve. Grass carp can control certain nuisance aquatic plants under the right circumstances, although the fish do demonstrate distinct food preferences. While Eurasian watermilfoil and waterlilies do not seem to be highly preferred species, especially where other edible species may be present, variable control of these weeds by grass carp has been

demonstrated in the Northwest (e.g., Silver Lake, Cowlitz County). Furthermore, control effects may be more slowly achieved with use of this biological agent than with other mechanical or chemical options listed above. Management studies in Washington waters indicate that substantial removal of vegetation by sterile grass carp may not become apparent until 3-5 years after introduction. Stocking rates are dependent on climate, water temperature, type and extent of plant species and other site-specific constraints. Thus, it will be necessary to develop specific stocking rates for Lake Twelve. An environmental assessment specific to Lake Twelve may also be required prior to implementation. Since an escape barrier on the outlet is required to prevent movement of fish out of the system and avoid impacts on downstream non-target vegetation, the scenario requires design and construction of a primary outlet structure at the lake/wetland interface. Because of the presence of the expansive, high quality wetland at the outlet end of the lake, a second barrier structure may be necessary at the double culverts downstream as an additional precaution. A second restocking of up to 30% of the initial fish quantity may be needed by year 3. The scenario also includes small-scale bottom barrier applications, if necessary in years 4 and 5.

Costs: Overall **first-year program costs** for this scenario include stocking rate design, outlet barrier design and construction, fish purchase and any required environmental assessment, as well as prevention and monitoring. The bulk of expenses for this scenario would occur in the first year and could total as much as **$309,000** if two outlet barriers were needed. However, successive annual costs are estimated to be less than **$3,000 for both years 2 and 3**, increasing to about **$14,000 in years 4 and 5** to cover any small-scale application of bottom barrier and required permits, if needed.

Ecological/human impacts: Since herbivorous grass carp demonstrate distinct food preferences, removal of certain beneficial native aquatic plants are most likely. Impacts of grass carp introduction on human health should be negligible to non-existent.

Permits/Special Requirements

Washington State Department of Fish and Wildlife (WDFW) requires a game fish planting permit prior to grass carp introduction to a water body. In addition, if outlet screening is necessary, hydraulic approval is required from the WDFW.. Washington Department of Natural Resources Natural Heritage Program must be contacted for assessment of threatened or endangered plant species. Bottom barrier application requires hydraulic approval from the WDFW, and may be subject to Shoreline Management Act and may need Shoreline permit for installation, dependent on scale and cost of barrier application.

Ideally, time required for State agencies to process a permit application is at least 45 days, but could be much longer if the

permit application is not properly completed. If multiple permits from several local, county or state jurisdictions are required, the overall processing time period could be extended as well.

Treatment Scenario #5

In-lake Treatments
(Major treatments contracted out)
Major treatment involving large-scale mechanical harvesting
Minor treatments: small-scale bottom barrier application
Minor treatments: hand-removal of plant, including roots
Other Program Elements
Public Awareness-Prevention Program.

- **Public meetings/posted signs on lake/ newsletters/media coverage**
- **Citizen watch for milfoil in lake**
- **Boat/Trailer Inspections-voluntary**

Program Monitoring and Effectiveness Evaluation.

This scenario adds the element of lake-wide harvesting, used as a cosmetic tool to keep the water column clear in those areas of heavy weed infestation (e.g., nearshore areas, especially boat launch). Harvesting of excess vegetation has the added advantage of removing from the lake a future source of nutrient and organic input (resulting from decay). Harvesting alone produces only short-term control of plant growth; long-term reductions in plant bed area cannot be expected. With this scenario, the primary, large-scale management goal is one of keeping high use areas free of nuisance, surfacing weeds. A small-scale goal would be as in previous scenarios to keep shallow, critical areas clear of weeds using more intensive methods such as bottom barrier applications or hand removal techniques. Implementation of watershed measures, public awareness and monitoring programs are included as in previous scenarios.

Costs: Contract costs for mechanical harvesting services currently vary from $700-1000/acre, depending on scale. Again, costs for small-scale bottom barrier application would depend on target area and barrier material; for example, 1 acre treatment would be upwards of $45,000, including purchase of high end materials. Shoreline permit fees could cost as much as $2500, depending on acreage of bottom barrier applied. With a lake management plan involving large-scale mechanical harvesting, small-scale bottom screening and hand removal, and inclusion of public awareness and monitoring elements, **first year costs** could run as high as **$72,500** including 1 acre of bottom barrier application. Annual expenses for this maintenance mode scenario should decline to approximately $50,000 or less after the first year, and eventually to under $30,000.

Ecological/human impacts: Mechanical harvesting is not species- specific and would result in removal of target milfoil and waterlilies as well as any non-target species intermingled with them. With regard to Eurasian watermilfoil, there would be a risk of creating fragments through harvesting activities that could be spread to other areas of the lake. But the risk would probably be

no worse than fragments formed by continual passage of boats through infested areas during the growth season. Efforts could be made to minimize spread of fragments perhaps by screening off critical areas during harvesting operations. Harvesting can result in unintentional removal of fish and other aquatic life utilizing plant beds for nesting, forage or refuge.

Permits/Special Requirements

Mechanical cutting (including battery-operated equipment) does require hydraulic approval from the Washington Department of Fish and Wildlife (WDFW). Also check with your local government to determine if local regulations apply to mechanical cutting operations.

Bottom barrier application requires hydraulic approval from the WDFW, and may be subject to Shoreline Management Act and may need Shoreline permit for installation, dependent on scale and cost of barrier application.

Ideally, time required for state agencies to process a permit application is at least 45 days, but could be much longer if the permit application is not properly completed. If multiple permits from several local, county or state jurisdictions are required, the overall processing time period could be extended as well.

Treatment Scenario #6

In-lake Treatments (Most treatments conducted by lake volunteers)

Lease/purchase of mechanical harvester equipment by community

Major treatment involving large-scale mechanical harvesting

Minor treatments: small-scale bottom barrier application

Minor treatments: hand-removal of plant, including roots

Other Program Elements

Public Awareness-Prevention Program.

- **Public meetings/posted signs on lake/ newsletters/media coverage**
- **Citizen watch for milfoil in lake**
- **Boat/Trailer Inspections-voluntary**

Program Monitoring and Effectiveness Evaluation.

This scenario differs from scenario #5 in the purchase and operation of harvester equipment by the Lake Twelve community. Again, lake-wide harvesting is used as a cosmetic tool to keep the water column clear in those areas of heavy weed infestation (e.g., shoreline areas, especially boat launch). Harvesting of excess vegetation has the added advantage of removing from the lake a future source of nutrient and organic input (resulting from decay) Harvesting alone produces only short-term control of plant growth; long-term reductions in plant bed area cannot be expected. Also, with regard to Eurasian watermilfoil, there would be a risk of creating fragments through harvesting activities that could be spread to other areas of the lake. But the risk would probably be no worse than fragments formed by continual passage of boats through infested areas during the growth season. Efforts could be made to minimize spread of fragments perhaps by

restricting harvesting to the densest sites and screening off critical areas during harvesting operations. Again, the large-scale management goal is one of keeping high use areas free of nuisance, surfacing weeds. A small-scale goal would be as in previous scenarios to keep shallow areas difficult to access with the harvester clear of weeds using more intensive methods such as bottom barrier applications or hand removal techniques. Implementation of watershed measures, public awareness and monitoring programs are included as in previous scenarios.

Costs: First year expenses include capital costs for purchase of equipment. Again, costs for small-scale bottom barrier application would depend on target area and barrier material; for example, 1 acre treatment would be upwards of $45,000, including purchase of high end materials. Shoreline permit fees could cost upwards of $2500, depending on total area of bottom barrier application With a lake management plan involving community operation of mechanical harvester, small-scale bottom screening and hand removal, and inclusion of public awareness and monitoring elements, **first year annual expenses** for this maintenance scenario could run as high as **$143,500** including purchase of a moderate-priced machine of $80,000 and up to one acre of bottom barrier application. Expenses should decline significantly in successive years to about $40,000 in years 2 and 3, and could be kept to approximately $20,000 or less by year 5.

Ecological/human impacts: Mechanical harvesting is not species- specific and would result in removal of target milfoil and waterlilies as well as any non-target species intermingled with them. With regard to Eurasian watermilfoil, there would be a risk of creating fragments through harvesting activities that could be spread to other areas of the lake. But the risk would probably be no worse than fragments formed by continual passage of boats through infested areas during the growth season. Efforts could be made to minimize spread of fragments perhaps by screening off critical areas during harvesting operations. Harvesting can result in unintentional removal of fish and other aquatic life utilizing plant beds for nesting, forage or refuge.

Permits/Special Requirements

Mechanical cutting (includes battery-operated equipment) requires hydraulic approval from the Washington Department of Fish and Wildlife (WDFW). Also local regulations should be checked for requirements regarding mechanical cutting operations.

Bottom barrier application requires hydraulic approval from the WDFW, and may be subject to Shoreline Management Act and may need Shoreline permit for installation, dependent on scale and cost of barrier application.

Ideally, time required for State agencies to process a permit application is at least 45 days, but could be much longer if the permit application is not properly completed. If multiple permits from several local, county or state jurisdictions are required, the overall processing time period could be extended as well.

TABLE J-1
ALTERNATIVE TREATMENT SCENARIOS FOR LAKE TWELVE AQUATIC PLANT MANAGEMENT

Treatment Scenarios	Treatment Elements	* Costs (est) First Year	* Costs (est) Second Year	* Costs (est) Third Year	* Costs (est) Fourth Year	* Costs (est) Fifth Year	Scenario Cost First 5 Years
Intensive Programs							
1 Full-scale Dredge	Dredge	$1,297,000 20 ac	$0	$0	$0	$0	
to depth of 2m between	Upland disposal+	$13,000-130,000	$0	$0	$0	$0	
(2m-4m depth contours)	Rodeo (0-2m)	$2,500 10 ac	$0	$1,900 7.5 ac	$0	$300 1 ac	
w/upland disposal	Bottom screen	$0 -	$45,000 1 ac	$22,500 0.5 ac	$22,500 0.5 ac	$22,500 0.5 ac	
(all work contracted)	Permitting/EA	$80,000	$0	$2,500 local	$2,500 local	$2,500 local	
	Public Ed/Milf Prev	$500+volunteer	$500+volunteer	$500+volunteer	$500+volunteer	$500+volunteer	
+cost dep on dist to site	Monitor/Evaluate	$3000+volunteer	$1500+volunteer	$1500+volunteer	$1500+volunteer	$1500+volunteer	
TOTALS		**$1,396,000 to $1,513,000**	**$47,000**	**$28,900**	**$27,000**	**$27,300**	**$1,526,200 to $1,643,200**
2 Full-scale Dredge	lease/purchase	$80,000	$0	$0	$0	$0	
to depth of 2m between	Dredge (100 days)	$227,000 4 ac	$227,000 4 ac	$227,000 4 ac	$227,000 4 ac	$227,000 4 ac	
(2m-4m depth contours)	Upland disposal+	$2,600-26,000	$2,600-26,000	$2,600-26,000	$2,600-26,000	$2,600-26,000	
w/upland disposal	Rodeo (0-2m)	$2,500 10 ac	$0	$1,900 7.5 ac	$0	$300 1 ac	
of all material	Bottom screen	$0	$45,000 1 ac	$22,500 0.5 ac	$10,000 0.2 ac	$0 reuse	
(resident operated equip)	Permitting/EA	$80,000	$2,500	$2,500 local	$1,300	$0	
	Public Ed/Milf Prev	$500+volunteer	$500+volunteer	$500+volunteer	$500+volunteer	$500+volunteer	
+cost dep on distance to site	Monitor/Evaluate	$3000+volunteer	$1500+volunteer	$1500+volunteer	$1500+volunteer	$1500+volunteer	
TOTALS		**$395,600 to $419,000**	**$279,100 to $302,500**	**$258,500 to $281,900**	**$242900 to $266,300**	**$231,900 to $255,300**	**$1,408,000 to $1,525,000**
3 Systemic Herbicide	Diver survey	$2,600 1 day	$2,800 1 day	$3,000 1 day	$0	$0	
phased application	SONAR application	$25,000 25 ac	$10,000 10 ac	$0	$0	$0	
w/bottom barrier	Rodeo application	$0	$1,300 5 ac	$0	$700 2.5 ac	$0	
	Mitigation *	$0	$0	$2,500 300 m	$0	$0	
	Wetland fringe surv			$2,500			
	Permitting	$2,500 local	$2,500 local	$2,500 local	$2,500 local	$2,500 local	
	Bottom screen w/Diver install	$0	$22,500 0.5 ac	$22,500 0.5 ac	$22,500 0.5 ac	$12,000 0.25 ac	
*replace damaged emergent	Public Ed/Milf Prev	$500+volunteer	$500+volunteer	$500+volunteer	$500+volunteer	$500+volunteer	
native vegetation	Monitor/Evaluate	$3000+volunteer	$1500+volunteer	$1500+volunteer	$1500+volunteer	$1500+volunteer	
TOTALS		**$33,600**	**$42,600**	**$35,000**	**$27,700**	**$16,500**	**$155,400**

TABLE J-1 (Con't) ALTERNATIVE TREATMENT SCENARIOS FOR LAKE TWELVE AQUATIC PLANT MANAGEMENT (con't)

Treatment Scenarios	Treatment Elements	* Costs (est) First Year	* Costs (est) Second Year	* Costs (est) Third Year	* Costs (est) Fourth Year	* Costs (est) Fifth Year	Scenario Cost First 5 Years
Intensive Programs							
4 Grass Carp Planting	stocking rate design	$2,400	$0	$0	$0	$0	
w/ primary barrier (at	grass carp purch1	$ 2,000-$3,000 200+ fish	$0	$0	$0	$0	
lake-wetland interface)	grass carp purch2	$0	$0	$600-900 30% init	$0		
w/secondary barrier	outlet struc1 mod	$0-250,000	$0	$0	$0	$0	
(at outlet culvert)	outlet struc2" mod	$10,000	$0	$0	$0	$0	
	Bottom screen w/Diver install	$0	$0	$0	$10,000 0.2 ac	$10,000 0.2 ac	
	permit/EA	$40,000	$0	$0	$1,300	$1,300	
"two barriers may not be required	Public Ed/Milf Prev	$500+volunteer	$500+volunteer	$500+volunteer	$500+volunteer	$500+volunteer	
	Monitor/Evaluate	$3000+volunteer	$1500+volunteer	$1500+volunteer	$1500+volunteer	$1500+volunteer	
TOTALS		**$57,900 to $308,900**	**$2,000**	**$2,600 to $2,900**	**$13,300**	**$13,300**	**$89,100 to $340,400**
Maintenance Programs							
5 Full-scale Harvesting	Harvesting	$21,000 30 ac	$22,000 30 ac	$23,000 30 ac	$24,000 30 ac	$25,000 30 ac	
shore-4.25 m	Bottom screen					$0	
(all work contracted)	w/Diver install	$45,000 1 ac	$22,500 0.5 ac	$22,500 0.5 ac	$10,000 0.2 ac	$0 reuse	
	hand removal	$500	$500	$500	$1,000	$1,500	
	permitting	$2,500 local	$2,500 local	$2,500 local	$1,300 local	$0	
	Public Ed/Milf Prev	$500+volunteer	$500+volunteer	$500+volunteer	$500+volunteer	$500+volunteer	
	Monitoring	$3000+volunteer	$1500+volunteer	$1500+volunteer	$1500+volunteer	$1500+volunteer	
TOTALS		**$72,500**	**$49,500**	**$50,500**	**$38,300**	**$28,500**	**$239,300**
6 Full-scale Harvesting	equip purch/lease	$80,000					
shore-4.25 m	operation/mainten	$12,000 30 ac	$12,000 30 ac	$13,000 30 ac	$14,000 30 ac	$15,000 30 ac	
(resident operated:	Bottom screen						
equipment leased)	w/Diver install	$45,000 1 ac	$22,500 0.5 ac	$22,500 0.5 ac	$10,000 0.2 ac	$0 reuse	
	hand removal	$500	$500	$500	$1,000	$1,500	
	permitting	$2,500 local	$2,500 local	$2,500 local	$1,300 local	$0	
	Public Ed/Milf Prev	$500+volunteer	$500+volunteer	$500+volunteer	$500+volunteer	$500+volunteer	
	Monitoring	$3000+volunteer	$1500+volunteer	$1500+volunteer	$1500+volunteer	$1500+volunteer	
TOTALS		**$143,500**	**$39,500**	**$40,500**	**$28,300**	**$18,500**	**$270,300**

* Cost based on contractors' current estimates multiplied by 30% to cover inflation, permitting and contingency expenses.

Recommended Action Plan for Lake Twelve
Step K

Recommended Plan

Realistically, aquatic plant management, particularly milfoil control in Lake Twelve will be an ongoing concern and will take a long-term commitment. Eurasian watermilfoil can be a tenacious and persistent pest. The difficulty in routing this weed from a system increases as plant coverage/density increases. Thus, the possibility of eliminating milfoil populations from Lake Twelve could realistically take many, many years under the best circumstances. As a result, a 5 year (minimum) program of aggressive in-lake treatment is proposed. With the goal of aggressive removal of all known Eurasian watermilfoil populations and intensive control of selected areas of waterlilies in Lake Twelve, Treatment Scenario #3 is highly recommended and discussed below.

Integrated Treatment Scenario

In-lake Treatments
Whole-lake (littoral) diver surveillance for milfoil
(Year 1)-Major treatment using SONAR, one annual application along entire lake littoral
(Year 2)-Major treatment using RODEO, one annual application at selected areas along lake littoral
-Minor re-treatment using SONAR, if necessary
(Year 4)-Minor retreatment of waterlily beds with RODEO, if necessary
(Year 1-5)-Minor treatments using hand removal and bottom barrier

Other Plan Elements
Establishing Action Team
Use Restrictions
Mitigation of damaged native emergent plants, if needed
Public Awareness-Prevention Program
- **Public meetings/posted signs on lake/ newsletters/media coverage**
- **Citizen watch for milfoil in lake**
- **Boat/Trailer Inspections-voluntary**

Program Monitoring and Effectiveness Evaluation
Permit Requirements
Implementation and Funding Alternatives

This integrated treatment scenario involves a combination of large-scale chemical methods in the first few years supported by small-scale physical methods. The plan includes provisions for **public awareness** and **annual monitoring/evaluation** to allow for making appropriate program adjustments. Finally, if removal of milfoil is achieved in Lake Twelve, it is crucial to sustain the **preventative surveillance program** to search for and attack new milfoil colony outbreaks. Other program components include

permit requirements, implementation and funding alternatives. Each of these program components is discussed separately below.

In-lake Treatments

The major treatment component of this scenario consists of an intensive, chemical treatment in the first few years using ***systemic herbicides*** that are actively absorbed by plant roots and shoots. Two different herbicides, SONAR and RODEO, are used that differentially target watermilfoil and waterlilies, respectively. In **year 1**, an initial survey of the lake littoral is conducted sometime in spring (e.g., April or May) to locate milfoil plants and determine extent of coverage in lake (recommend surface survey with a diver for underwater inspection). Upon completion of the survey, control elements can be initiated ideally early in the milfoil growth season (May to July). In this scenario a large-scale application of SONAR (fluridone) is made along the entire shoreline of Lake Twelve during the late spring season following the lakewide survey. The fluridone application would be made targeting milfoil beds between 1 and 4 meter water depth (where milfoil growth was concentrated as of July 1994), approximately 24 acres total (Figure I-1). The appropriate formulation of SONAR should be used, with application made at the recommended label rate for milfoil control. Currently, lakewide applications of fluridone are made to supply an initial concentration of 10-20 ppb in lake water for milfoil control (See SONAR label, Appendix D). A sampling program will be necessary to collect lake water samples at regular intervals to monitor fluridone concentrations in the lake.

Year 2+: As in year 1, an early season, pre-treatment surface/underwater diver inspection of the lake littoral is recommended. Depending on the effectiveness of milfoil removal in Lake Twelve following the first year SONAR treatment, another SONAR application may be necessary in the following year to hit regrowth. Block applications of SONAR possibly covering up to 10 acres may be needed in year 2.

Treatment of selected waterlily beds with aquatic herbicide glyphosate (RODEO) is delayed to year 2 in order to assess extent of non-target impacts on the lilies by first-year SONAR application. In early summer of year 2, when waterlily growth is more apparent, application of RODEO is made along priority shoreline areas between 1m and 3.25 m depth (estimate up to 5 acres), but avoiding the buffer area less than 1 m depth abutting the east end wetland (Figure I-1). RODEO is applied to the surface of individual emergent plants at recommended label rates. A retreatment of waterlily beds with RODEO (estimate up to 2.5 acres) may be needed in year 4.

The IAPMP for Lake Twelve also recommends small-scale manual or physical plant removal methods to be used around the shoreline, if necessary. Later in the season of year two, when evidence of kill effectiveness is more apparent (2-3 months later),

cleanup treatment of unaffected milfoil plants by hand removal (digging) or bottom screening application may be necessary. In succeeding years, hand removal of small milfoil patches is recommended, as well as maintenance and reapplication of bottom barriers, if needed.

Optional Biomass Removal

Toxicity effects of fluridone on vegetation are slow, taking up to 1-3 months to become visually evident. Although plants may be dead or dying at the end of that time, there is a concern about the resultant biomass and whether dieback will release additional nutrients into the water column and fuel an algal bloom. The process of plant death is slow, so potential nutrient releases should be correspondingly slowed too. If non-target plants are not substantially damaged by the SONAR treatment, unimpacted plants could continue to take up the extra nutrients, providing a mechanism for natural mitigation and perhaps staving off an artificially-induced algal bloom. As an optional activity in year 1, dead and dying plant biomass could also be removed by mechanical harvesting after a suitable length of time to allow full absorption of fluridone into the milfoil plants (e.g., 3 months following treatment). Similarly, harvesting removal of dead, floating glyphosate-affected waterlilies may be an option in late summer of year 2. Of course, implementing this harvesting option will add up to $1000/acre to the total annual cost of the program, unless volunteer removal efforts are used. **NOTE: Implementation of this option should be assessed by the Action Team (See discussion below).**

Other Plan Elements

Establishing Action Team

It is highly recommended that an ***Action Team*** be established prior to implementation of aquatic plant management activities in Lake Twelve. The team would be formed for the purpose of making critical decisions on issues that may arise regarding specifics of the program. Team members could include, for instance, representatives of the lake community, state and local agencies, tribal members, and aquatic plant management professionals. Critical issues may include timing of herbicide treatment, precise application rates and formulation, and water sampling schedule, if required.

Use Restrictions

There may be some recreational impacts with the use of SONAR, affecting mostly swimming, which is discouraged during and immediately after treatment, although there is no label restriction for swimming (See SONAR label, Appendix D). However, because SONAR treatments are most effectively made between April-July for milfoil control, recreational impacts can be kept to a minimum by early season application. There are irrigation restrictions with SONAR use. Glyphosate treatment does carry a label restriction on use when applied within 1/2 mile of potable intakes, requiring a shutoff on all such intakes for a minimum of 48 hours or until glyphosate levels drop below 0.7 ppm. As a result, lake residents should use ***alternative drinking water***

sources, such as purchasing commercially sold, bottled water for an appropriate period of time during and following RODEO application as well as SONAR treatment.

Mitigation

SONAR may impact other non-target native plants in Lake Twelve and its associated wetlands. However, concerted efforts to employ a prudent application scheme should minimize impacts to emergent plants on the lakeshore perimeter of Lake Twelve. Because of dilution effects in the lake, any impacts of the active ingredient, fluridone, on the wetland at the east end of the lake should be minimal. Also, delaying the SONAR treatment to late spring-early summer, when precipitation and outflow through the wetland decline substantially, should further minimize downstream movement of the herbicide. Such efforts as well as development of a mitigation plan for revegetation of damaged areas are expected to satisfy the Governor's Executive Order 11990, Protection of Wetlands. These actions should also satisfy the Washington Department of Fish and Wildlife's reccomendation that a minimum of 25% of aquatic vegetation be preserved for wildlife habitat in lakes treated with herbicides. Because at least two SONAR treatments may be necessary, mitigation efforts (to revegetate any damaged native emergent plants along shoreline areas) are delayed to year three to allow time for full effects to become obvious. Mitigation need should be determined in year 3 by performing a basic survey of the wetland strip bordering the outflow stream of Lake Twelve to assess condition of emergent plants. Results should be compared to the pre-existing data compiled on the Lake Twelve wetlands (check King County database).

Public Awareness/ Exotic Weed Prevention Program

The Lake Twelve IAPMP also includes a multi-faceted public awareness/milfoil prevention element. Public outreach efforts are encouraged on a year-round basis to keep the larger community informed as to the status and progress of nuisance aquatic plant control in Lake Twelve. This can be accomplished by continuation of regular newsletters mailed to Lake Twelve Association members, conducting public and informal meetings, and posting lake information on local bulletin boards. Public Education efforts resulting from the Integrated Aquatic Plant Management Plan should complement existing programs previously recommended in the Phase I study (Envirovision, 1994).

The purpose of the exotic weed prevention element is to prevent reintroduction of milfoil, or other non-native invasive plants, to the lake and provide a quick response if new populations are sighted. While Eurasian watermilfoil is presently the species of concern in Lake Twelve, it is important to prevent introduction of other exotic species such as Brazilian elodea (*Egeria densa*), parrotfeather (*M. aquaticum*), and fanwort (*Cabomba caroliniana*), all of which have documented, established populations in western Washington waters. While established, persistent populations have yet to be documented in Washington waters, it is also critical to be on the alert for other exotic nuisance species, hydrilla (*Hydrilla verticillata*) and water hyacinth (*Eichhornia crassipes*).

Since spread of milfoil fragments most commonly occurs as a result of transport on boating equipment (Newroth, 1990), efforts to halt spread through educational means and by visual inspection of boats entering/leaving the lake are recommended. A milfoil prevention sign developed by King County SWM is currently posted at the Lake Twelve public boat launch. As part of the planning process, consideration was also given to the feasibility of a boat check and washing operation at Lake Twelve boat ramp. Due to high projected costs for physical washing alternatives (See Appendix E), it was recommended that a boat checking operation could be undertaken staffed by volunteers from the community. Inspection efforts should be targeted for typical high-use periods, e.g., from April (opening day of inland fishing) to July.

Regular patrolling of Lake Twelve should be conducted to check for outbreaks of milfoil or other non-native, invasive plants. At least six lake residents should be trained to look for Eurasian watermilfoil as well as other dangerous exotic invasive plants. The Citizen's Manual for Developing Integrated Aquatic Vegetation Management Plans (Gibbons et. al., 1994) provides a description and line drawings of these and other exotic invasive plants. Surveillance should be made monthly from April to October, using an underwater viewer to see into the water, and pulling suspect plant samples with a rake for a surface check. Washington Department of Ecology can be consulted for expert identification of aquatic plants.

Program Monitoring and Evaluation

The monitoring/evaluation component consists of at least annual surveying and evaluating effectiveness of in-lake control activities and other program elements. By performing a periodic "checkup" of the lake, appropriate adjustments can be made in the succeeding year's management program to maximize program effectiveness. With so much time, effort and money behind the integrated aquatic plant management program, the importance of an annual program evaluation cannot be over-emphasized. Program results should be evaluated with respect to aquatic plant management goals set for the lake, and produced into a written report. The following offers some guidelines for evaluating progress of the program in achieving major management goals.

Major Goal: To aggressively remove noxious Eurasian watermilfoil populations from all known locations in the lake. As discussed earlier, accomplishment of this goal will take aggressive, persistent, long-term efforts. To get a quantitative handle to measure progress on this goal, type and extent of aquatic plants need to be assessed from year to year. Aquatic plant mapping similar to the procedure performed during summer of 1994 should be continued for at least 5 years, with more detailed surveys in the first two years. During the summer season, community composition and areal estimates of plant beds should be made, as well as locations and biomass estimates of any milfoil beds. These surveys should be supplemented with results of

volunteer surveillance as described above. A detailed evaluation report should be prepared including this comparative data, particularly as it relates to the 1994 pre-treatment survey results. Costs for aquatic plant mapping and biomass measures are estimated to be about $3000/year for the first two years and $1500 annually thereafter.

Major Goal: To keep priority areas, the boat launch and selected shoreline residential areas clear of plants for boating and swimming safety reasons. Nuisance growth of waterlilies (mainly white and colored species) and watershield, to a lesser extent, are the main concern in the shallow nearshore areas of Lake Twelve where swimming occurs. These plants may be incidentally affected by SONAR application in year 1 and selectively targeted in year 2 (and year 4, if needed) by a Rodeo application. From year 2 on, small-scale treatments of waterlily beds will be necessary, employing hand-pulling (limited) and placement of bottom barriers. Success of these measures can be evaluated quantitatively in terms of the annual aquatic plant mapping results described above. An additional measure of success can be supplied through results of an annual opinion survey of lake residents regarding shoreline lily beds.

Major Goal: To maintain sufficient habitat for fish and wildlife. While both fluridone and glyphosate applications can be made in a way to maximize selectivity for milfoil and waterlilies, non-target plants may be variably affected. Thus, declines in plant bed area may be most apparent in year 2 (following possible treatment with both herbicides). Succeeding years should see nuisance plant populations replaced by native species, and continued maintenance of habitat for fish and wildlife. The annual macrophyte survey will provide plant community composition as well as areal coverage estimates, generating a useful means to gage achievement of this goal.

Major Goal: To preserve the high quality wetland adjacent to the east end of the lake. There is a considerable database currently maintained by King County on the wetland system associated with Lake Twelve. This data could serve as a pre-treatment plant community baseline. The monitoring effort in year 3 should also include a basic survey of the wetlands bordering the outflow stream of Lake Twelve to assess condition of emergent plants. Results should be compared to the existing baseline data compiled on the Lake Twelve wetlands (check King County database), and the need and extent of mitigation determined.

King County Regulations And Permit Requirements

Shoreline Management

The King County Shoreline Management code (K.C.C. 25) implements the state of Washington's Shoreline Management Act of 1971. According to the Shoreline Management Act, a shoreline permit is required for "substantial development" projects, i.e. any development in which the total cost or fair market value exceeds

$2,500 or any development which materially interferes with the normal public use of the water or shorelines of the state. Activities such as dredging and removal of materials are considered development activities.

A shoreline permit exemption can be obtained from the King County Department of Development and Environmental Services (DDES) if bottom barriers are used to control growth of noxious weeds, e.g. milfoil. This costs $276. A shoreline permit is required from DDES if bottom barriers are used to control growth of other plants which are not classified as noxious weeds, e.g. water lilies. A shoreline permit is also required for herbicide use if lake water use will be restricted or if herbicide costs exceed $2,500. Approximately 90 to 120 days are required to obtain the permit.

Shoreline permit fees depend on project cost: $1,280 if the project cost is between $2,500 and $10,000; $2,560 if the project cost is between $10,000 and $100,000; and $6,399 if the project cost is between $100,000 and $500,000. Based on the estimated costs for implementation of the Lake Twelve IAPMP, a shoreline permit for Sonar and Rodeo treatments of the lake would cost $6,399.

Clearing and Grading

A grading permit must be obtained from the King County Department of Development and Environmental Services (DDES) for all projects and activities which may involve clearing or grading, including aquatic vegetation removal and management. The King County Clearing and Grading Code (K.C.C. 16.82.050) details the exceptions to this requirement and includes an allowance for the removal of noxious weeds. Therefore, an exception can be obtained for milfoil removal but a permit would be needed for water lily removal. The base fee for the permit is $367.50. If the proposed action required a substantive review, there would be an additional fee of $512.

Zoning Code - Environmentally Sensitive Areas

The King County Zoning Code (K.C.C. 21A.24), environmentally sensitive areas chapter, currently prohibits the removal of aquatic vegetation (by herbicides or by other methods) from wetlands. Noxious weeds can be removed from buffer zones of wetlands (25 to 100 feet from the wetland edge depending on the wetland class). At present, the interpretation of the code is that lake shoreline areas with wetland characteristics are regulated as wetlands.

Community groups or public agencies can apply for an exemption from this provision of the code if they can prove that removal of the aquatic vegetation will "protect, restore, or enhance the wildlife habitat, natural drainage or other valuable functions of the wetland resulting in a net improvement to the functions of the wetland system." SWM is currently examining the regulatory framework and developing justifications for implementation of aquatic plant management activities on Lake Twelve and other King County lakes.

Plan Costs

First Year Costs: Cost for use of private divers (for pre-treatment survey, milfoil removal, bottom barrier application) range upwards of $1500 to $2000/day. At an average cost for materials and application by private contractor of roughly $1000/acre, first year costs for an application of SONAR (25 acres) could be upwards of $25,000. It is anticipated that the public outreach/exotic weed prevention component would be mainly a volunteer effort, with expenses estimated to be under $500. Local shoreline permit fees could cost upwards of $2500. Monitoring costs for a lake management professional to evaluate carry-over effectiveness in the lake are estimated to be $3,000. Thus, first year program costs could be as much as **$33,600**, assuming at least 1 day for diver services and materials expenses.

Costs for Year 2+: The bulk of program costs for scenario 3 will most likely occur in year 2 ($41,600). This is because of a possible need for additional SONAR retreatment, a RODEO application, and diver hand removal/bottom barrier application, all depending on efficacy of the first year herbicide treatments. At an average cost of $250/acre, a 5 acre application of RODEO would cost approximately $1300. As in year 1, shoreline permit fees could cost upwards of $2500. Total annual costs for an herbicide-based program for milfoil/waterlily control in Lake Twelve using SONAR/ RODEO and supported by physical removal methods using a diver should successively decline after the second year, approaching costs of $33,000 or less, depending on scale of physical control methods needed each year. The main cost in the latter years will most likely be purchase and installation of new bottom barrier material. Mitigation efforts are delayed to the third year to allow time to estimate revegetation needs resulting from any herbicide damage to wetland fringe plants. A basic survey of the fringe area of the wetland bordering the outflow stream from Lake Twelve should be made in the spring of the third year and compared to baseline data. Based on results of similar herbicide programs in Washington State, emergent plant revegetation cost should be minimal. For example,

TABLE K-1
ESTIMATED COSTS FOR IMPLEMENTATION OF LAKE TWELVE IAPMP

Treatment Scenarios	Treatment Elements	Costs (est) First Year	Costs (est) Second Year	Costs (est) Third Year	Costs (est) Fourth Year	Costs (est) Fifth Year
Systemic Herbicide phased application w/bottom barrier and hand removal	Diver survey	$2,600	$2,800	$3,000	$0	$0
	SONAR application	$25,000	$10,000.00	$0	$0	$0
	Rodeo application	$0	$1,300	$0	$700	$0
	Mitigation *	$0	$0	$2,500	$0	$0
	Wetland fringe survey			$2,500		
	Permitting	$2,500	$2,500	$2,500	$2,500	$2,500
	Bottom screen w/Diver install	$0	$22,500	$22,500	$22,500	$12,000
*replace damaged emergent native vegetation	Public Ed/Prevent	$500+volun	$500+volun	$500+volun	$500+volun	$500+volun
	Monitor/Evaluation	$3000+vol	$3000+vol	$1500+vol	$1500+vol	$1500+vol
TOTALS		$33,600	$42,600	$35,000	$27,700	$16,500

if 300 m^2 (1m X 300m) of shoreline area were affected, revegetation estimates would be about $2,500 relying largely on volunteer labor. Projected costs for a five year program on Lake Twelve are estimated to be $155,400.

Plan Implementation And Funding

As indicated above, the recommended alternative for aquatic plant management in Lake Twelve involves a combination of (1) herbicide treatments, (2) follow-up with hand removal and bottom barriers to prevent reinfestation, (3) a public awareness/milfoil prevention program, and (4) a monitoring program to evaluate effectiveness. Implementation is estimated to require five years and cost $155,400. A combination of grant funding and local revenue from lake management district formation is proposed to fund the implementation of the Lake Twelve IAPMP over five years. In order for plan implementation to be successful, the Lake Twelve Association (LTA) and King County SWM will need to maintain consistent communication throughout the plan implementation period with the Muckleshoot Tribe, the Washington State Department of Fish and Wildlife, the Washington State Department of Ecology, other permitting agencies, the contracting herbicide applicator, and other interested parties.

Grant Funding

The Lake Twelve IAPMP was developed under an Aquatic Weeds Management Fund (AWMF) planning grant from the Washington State Department of Ecology. The grant provided 75 percent of the funding; SWM and the LTA have provided the remaining 25 percent via staff time and in-kind volunteer services respectively.

SWM will apply for an AWMF implementation grant during the next grant application period (July, 1995). The AWMF grant program is competitive. If the grant is awarded, plan implementation would begin in 1996 pending a source of local matching funds. The grant would fund up to 75 percent of the costs of implementing the Lake Twelve IAPMP. The Lake Twelve community would be required to fund the remaining 25 percent. This could be accomplished through a lake management district.

Lake Management Districts

A lake management district (LMD) is a community-defined assessment to raise revenue for lake protection or improvement activities. Property owners on or near a lake pay a special charge on their property, either annually or on a one-time basis. LMDs can be formed for up to a 10 year period. LMDs have operated successfully in Snohomish and Thurston counties. Grant matching funds could be generated and/or specific Lake Twelve IAPMP recommendations could be implemented through LMD formation.

Section 36.61 of the Revised Code of Washington describes the process for LMD formation. According to the law, an LMD can be initiated through a petition to the Metropolitan King County Council by property owners of at least 15 percent of the acreage

within the proposed LMD boundary or by the County Council who can adopt a resolution of intention. The petition or resolution of intention needs to include the following information: (1) proposed lake protection or improvement activities, (2) total amount of money to be raised, (3) whether money will be collected annually or one-time only, (4) amount of annual assessment, (5) duration of LMD, and (6) proposed LMD boundaries.

After the petition is adopted or the resolution of intention is passed, a public notice is sent and a public hearing is held. This is followed by a special election in which each property owner has one vote for every dollar of proposed assessment. The proposed LMD must be approved by a simple majority of the votes cast. If there is a positive vote, the County Council then adopts an ordinance to create the LMD. If there are no appeals, the County Assessor prepares a special assessment roll which lists each property and the proposed special assessment. There is a second public hearing at which individuals can raise objections to the amount of the special assessment. The County Council may revise the special assessment roll in response. Then the special assessment roll is confirmed and billing can proceed. The money is administered by King County, but a community-based advisory board can be appointed by the County Council to oversee the project expenditures.

The process of forming an LMD takes at least 12 months. If SWM were to receive an AWMF grant in 1996 and complete LMD formation in 1996 (see proposed implementation schedule), the Lake Twelve community would need to contribute 25 percent or approximately $38,850. One possible scenario is that the LMD would exist from the years 1996 through 2000. Property owners in the LMD would collectively pay $7,770 per year. If there were equal charges for each of the 74 parcels on Lake Twelve, each parcel would contribute approximately $105 per year.

Implementation Schedule

Implementation of the Lake Twelve IAPMP is contingent on a variety of factors including: (1) the availability of funding, (2) the success of grant applications, and (3) the successful formation of an LMD. Listed below is a proposed IAPMP implementation schedule which assumes that grant funding and LMD formation will be pursued and will be successful.

* Final IAPMP	June1995
* Apply for AWMF Grant	July 1995
* Initiate LMD formation	July 1995
* LMD Petition or Resolution of Intention	October 1995
* Initiate IAPMP implementation	March 1996
* Complete LMD formation	July 1996
* Initiate collection of LMD revenues	September 1996

In the interim between plan development/approval and initiation of control action in Lake Twelve, it may be possible to conduct selected short-term weed control in the lake. For example, Lake Twelve might offer a possible site for testing of the Crary Weedroller by King County SWM during the summer of 1995.

Literature Cited

American Public Health Association (APHA). 1985. Standard Methods for the Examination of Water and Wastewater, 16th ed. APHA, AWWA, WPCF. 1268 pp.

Bortleson, G.C, N.P. Dion, J.B. McConnell, and L.M. Nelson. 1976. Reconnaissance Data on Lakes in Washington, Water Supply Bulletin 43, Volume 2, King and Snohomish Counties. Prepared by Washington Department of Ecology and U.S. Geological Survey. 424 pp.

Canfield, D.E.Jr., K.A. Langeland, S.B Linda, and W.T Haller. 1985. Relations Between Water Transparency and Maximum Depth of Macrophyte Colonization in Lakes. *J. Aquat. Plant Manag.* 23: 25-28.

Cooke G.D, E.B Welch, S.A. Peterson, and P.R. Newroth. 1993. Restoration and Management of Lakes and Reservoirs, Second ed. Lewis Publishers, Boca Raton. 548 pp.

Envirovision. 1994. Lake Twelve Management Plan. Technical Report prepared for King County Surface Water Management, May, 1994.

Gibbons, M.V., H.L. Gibbons, and M.D. Sytsma. 1994. A Citizen's Manual for Developing Integrated Aquatic Vegetation Management Plans, First ed. Washington Department of Ecology, No. 93-93.

Hitchcock, C.L. and A. Cronquist. 1981. Flora of the Pacific Northwest. Univ. of Washington Press, Seattle. 730 pp.

Hotchkiss, N. 1972. Common Marsh, Underwater & Floating-leaved Plants of the United States and Canada. Dover Publ., New York. 235 pp.

Municipality of Metropolitan Seattle (METRO). 1978. Aquatic Plants in Selected Waters of King County: Distribution and Community Composition of Macrophytes, pp. 48-50.

_____, 1979. Aquatic Plants in Selected Waters of King County: Distribution and Community Composition of Macrophytes, pp. 30-31.

_____, 1980. Aquatic Plants in Selected Waters of King County: Distribution and Community Composition of Macrophytes, pp. 28-29.

Newroth, P. R. 1990. Prevention of the Spread of Eurasian Water Milfoil. In, Proceedings, National Conference on Enhancing the States' Lake and Wetland Management Programs, Chicago, Ill, Feb. 1990, USEPA/NALMS, pp. 93-100.

Perkins, M.A. and M.D. Sytsma. 1987. Harvesting and Carbohydrate Accumulation in Eurasian Watermilfoil. *J. Aquat. Plant Manag.* 25: 57-62.

Smayda, T. 1988. Water chemistry and algal blooms in Lake Number 12: Impacts of coal strip mining. Harper-Owes, 29pp with appendices.

Thomas, G.L., J.D. Frodge, S.A. Bonar, and G.B. Pauley. 1990. An Evaluation of Triploid Grass Carp Grazing on Ponds and Lakes of the Pacific Northwest. Washington Cooperative Fishery Research Unit, Univ. of Washington, Seattle, Washington. Fifth Progress Report prepared for Washington Department of Ecology.

Truelson, R.L. 1985. Assessment of the 1984 Eurasian Water Milfoil Control Program in Cultus Lake. Water Management Branch Rep. No. 3308. British Columbia Ministry of Environment.

_____, 1989. Use of Bottom Barriers to Control Nuisance Aquatic Plants. Water Management Branch Rep. British Columbia Ministry of Environment.

U S Department of Interior. 1987. Black Diamond, Washington, Final Petition Evaluation Document/Enviornmental Impact Statement (PED/EIS), October, 1987. Office of Surface Minimg Reclamation and Enforcement.

Warrington, P.D. 1980. Aquatic Plants of British Columbia. Studies on Aquatic Macrophytes. Part XXXIII. British Colum. Min. Envir.

_____ 1994. Identification Keys to the Aquatic Plants of British Columbia. Discussion Document. Water Quality Branch, Water Manage Division, British Colum. Min. Envir.

Washington Department of Ecology (WDOE). 1992. Aquatic Plant Management Program for Washington State. Final Supplemental Environmental Impact Statement and Responsiveness Summary Vol. 1, January, 1992.

Welch, E.B, J.E. Beiler, and D.E. Spyridakis. 1993. Lake Twelve Quality, Nutrient Loading and Management. Water Resources Series Tech. Rep. No. 135. University of Washington, Seattle. 81 pp with appendices.

Westerdahl, H.E. and K.D. Getsinger. 1988. Aquatic Plant Identification and Herbicide Use Guide, Vol. II: Aquatic Plants and Susceptibility to Herbicides. Technical Report A-88-9, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Appendix A
Lake Twelve Workshop and Steering Committee Meeting Notes

LAKE TWELVE INTEGRATED AQUATIC PLANT MANAGEMENT PLAN (IAPMP) PROJECT STEERING COMMITTEE MEETING

1ST

Date: Monday, May 9, 1994

Time: 4:00 to 6:00 PM

Place: Ray Drury's house
27423 SE 306th
Black Diamond

AGENDA

1.	Introductions	4:00 - 4:10 PM
2.	Project Overview	4:10 - 4:30 PM
3.	Review of Steps for Developing an IAPMP; Steering Committee Member Comments on Problem Statement, Management Goals, and Lake Twelve Beneficial Uses	4:30 - 5:40 PM
4.	Field Work: Volunteers and Schedule	5:40 - 5:50 PM
5.	Next Meeting: Agenda and Schedule	5:50 - 6:00 PM

This project is funded in part through a Washington State Department of Ecology Aquatic Weeds Management Fund grant.

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May 24, 1994

TO: Lake Twelve Steering Committee

FS FM: Fran Solomon, Ph.D., Senior Limnologist, Water Quality Unit

RE: Meeting Notes (1ST)

Thank you all for your energy and good ideas at the first Steering Committee meeting of the Lake Twelve Integrated Aquatic Plant Management Plan (IAPMP) project. Enclosed are the meeting notes and a flyer about a free aquatic plant workshop that will take place on Saturday, June 18.

At the Steering Committee meeting, we began to work on the IAPMP by defining the problem statement, management goals, and beneficial use areas for Lake Twelve. By June 3, please phone or mail any additional ideas to me or to the project consultant Maribeth Gibbons. See the meeting notes for our addresses and phone numbers. Maribeth will incorporate your ideas into a draft problem statement, management goals, and beneficial uses summary.

I will mail this information to you in mid-June, along with an agenda for the next Steering Committee meeting. That meeting will take place on Monday, June 27 from 4:00 to 7:00 PM at Dick Hansen's property on the north shore of Lake Twelve (Lot 19, 27221 SE 306th Street), and will include training for the field work to be performed this summer.

Please call me if you have any suggestions for the next meeting's agenda or any questions about the Lake Twelve IAPMP project.

Enclosures

cc: Bill Eckel, Manager, Water Quality Unit

1ST
LAKE TWELVE IAPMP PROJECT STEERING COMMITTEE MEETING NOTES
May 9, 1994, 4:00 to 6:00 PM, Ray Drury's house

Dr. Fran Solomon, Senior Limnologist at the King County Surface Water Management (SWM) Division, welcomed everyone to the first meeting of the Steering Committee for the Lake Twelve Integrated Aquatic Plant Management Plan (IAPMP) project. Fran is the project manager. Maribeth Gibbons, President of WATER Environmental Services, is the project consultant. Dr. Harry Gibbons, Program Manager of Lake Restoration/Water Quality Services at KCM, Inc. is the subcontractor. Maribeth and Harry wrote A Citizen's Manual for Developing Integrated Aquatic Vegetation Management Plans, which will be used in developing the Lake Twelve IAPMP.

Steering Committee members introduced themselves. Ray Drury has lived on Lake Twelve for 12 years and is a member of the Lake Twelve Association (LTA). From his house, we were able to see the milfoil that is still in the lake from this past winter. Esko Cate has lived on Lake Twelve since 1979 and is president of the LTA. Dick Hansen has owned a vacation home on Lake Twelve for the past three years. He has observed a doubling of aquatic plant growth during this time. Dave Carter is a founder and board member of the LTA, and has lived on the lake for 12 years. He has noticed a marked increase in the lake area that is infested with milfoil. The milfoil was probably introduced into the lake via the public boat launch. Carolyn Carter has owned property on Lake Twelve since 1979. She pointed out that the lake was clear and there were no aquatic weeds present in the late 1960s when fewer people lived on the lake. Bill Kombol, the manager of the Palmer Coking Coal Company, has lakeside property.

Fran presented an overview of the project, which is funded by an Aquatic Weeds Management Fund grant from the Washington Department of Ecology (WDOE). The project goal is: the Lake Twelve community, King County SWM, and the project consultant will work cooperatively to develop an IAPMP for Lake Twelve that balances water quality, recreational uses, and fish/wildlife habitat.

The grant delineates four project tasks (see the handout distributed at the meeting for details). Task 1 is an aquatic plant/lake inventory and will be conducted this summer. The Steering Committee pointed out that the lake bottom is mucky and flocculent and asked how we will differentiate the real (hard) bottom from the beginning of the muck. Maribeth explained that she will use a combination of sounding with a fathometer and a traditional bottom sounding weight and Secchi disk.

Dick asked if weed cutting would affect our aquatic plant sampling efforts. Harry requested that weed cutting not take place during the three weeks prior to sampling.

Task 2 is development of an IAPMP that emphasizes action strategies for both short-term and long-term aquatic plant management. A draft plan will be completed by November 1, 1994; it will be finalized by January 31, 1995. The Steering Committee will guide the development of the IAPMP, with input from the LTA throughout the process.

Task 3 is public involvement and education. Public input, review, and hands-on involvement are critical to the success of the project. There will be two public workshops: one on the results of the 1994 macrophyte survey, and the second on the draft IAPMP. The draft IAPMP that is presented to the general public will be a document that the Steering Committee has developed.

The Steering Committee will identify alternatives for a nonpotable water source at the public boat ramp for washing milfoil off boats and trailers. Fran will draft language for an educational sign about milfoil. The Steering Committee will review the language and will install the sign at the boat ramp this summer. The Steering Committee and Fran will review the Citizens Manual. Fran will send copies of the manual to Ray and Bill. Other committee members have their own copies.

Steering Committee members pointed out that the public boat launch, which is used from April through October, is operated by the Washington Department of Fisheries and Wildlife in cooperation with King County. Currently, there are no restroom facilities at the boat launch. Fran will ask the Washington Department of Fisheries and Wildlife about installing a Port-A-Potty.

Task 4 is project management. This involves coordination between SWM and the project consultant, and between SWM and WDOE via progress reports, financial reports, and meetings.

Maribeth reviewed the eleven steps to be followed in developing an IAPMP, as outlined in the Citizens Manual. She emphasized that public involvement is at the hub. The Steering Committee steers the process and represents the Lake Twelve community in developing the IAPMP.

Maribeth led a discussion of Step A - Develop the Problem Statement, Step B - Identify Management Goals, and Step E - Identify Waterbody Use Areas. She explained that there is a delicate balance between algae and aquatic plants. When one component of a lake ecosystem is wiped out or seriously disturbed, the result can be trouble with another component. For example, aquatic plants are sinks for nitrates and phosphates.

If aquatic plants are totally eradicated, the nutrients present in the lake will cause large algal blooms.

Dave suggested that the problem statement for Lake Twelve should describe all non-native plants as nuisances, e.g. fast-growing, noxious, non-native milfoil. Ray suggested that the highest priority management goal for the lake should be aggressive control of milfoil and white lilies, i.e. reduce their level to that of 10 to 12 years ago. Bill said that balance is important. Lake Twelve is out of balance, unlike other lakes such as Pine Lake. Esko said that the primary goal should be to re-establish balance between water quality and aquatic plants. Maribeth pointed out that this balance is for the committee to determine. Harry added that the committee needs to determine how green they will tolerate the lake, and how much water clarity is needed.

Swimming, fishing, and boating were identified as the beneficial uses of the lake and its shoreline. The entire lake is used for all activities. There are no dedicated swimming beaches; everyone swims off their dock.

The wetland adjacent to the lake is an important resource. Fran will provide Maribeth with information on wetlands delineations performed during the Lake Twelve Restoration Study. Dave gave Maribeth a copy of the Palmer Coking Coal Environmental Impact Statement.

Several people said that bald eagles and ospreys use the lake as a feeding ground. Fran will ask the Washington Department of Natural Resources and the Washington Department of Fisheries and Wildlife to check their databases for information on plants and animals in the Lake Twelve watershed. Esko will send Fran a list of property owners and a map showing the location of their properties. Maribeth will draft a problem statement, management goals, and a description of waterbody use areas before the next Steering Committee meeting.

Several Steering Committee members volunteered to assist Maribeth with field work in late July or early August. She would like four teams, with two people per team. Esko will recruit additional volunteers from the LTA. Volunteer training will take place at the next Steering Committee meeting at Dick Hansen's property (Lot 19, 27221 SE 306th Street) on Monday, June 27 from 4:00 to 7:00 PM. Bill Kombol's property can be used for overflow parking. All interested volunteers from the community are welcome at the meeting.

1ST MTG

Summary of IAPMP Steps

Designing a cost-effective and environmentally sound aquatic plant management program is seldom a simple task. Mapping a course of action can be greatly aided by careful development of an *integrated aquatic plant management plan* (IAPMP). The IAPMP provides a means to make water body management decisions that are effective and sensitive to public opinion, maximize recreational, aesthetic and wildlife benefits, and minimize threats to human health and the environment. Such a plan also assures that aquatic plant management is consistent with other management plans affecting the water body and surrounding watershed. Further, the state of Washington does require an integrated plan before implementation of certain aquatic plant control activities can occur.

The following briefly describes the general steps needed to complete an integrated aquatic plant management plan for a water body (a lake, pond, reservoir or river). The planning process consists of two phases: ***Phase I (Problem/Site Characterization)*** and ***Phase II (Control Strategies Development).***

PHASE I (Problem/Site Characterization)

Step A. Develop Problem Statement.
This step involves developing a realistic problem statement describing the limitations imposed by problem aquatic plant growth on beneficial uses of the water body.

Step B. Define Management Goals.
Once the problem is defined, the next step is to identify reasonable management goals that maximize beneficial uses of the water body, yet are compatible with the water body's capacity to meet human needs.

Step C. Involve the Public.
The management of an aquatic system is an active process and benefits from participation of all who use or have an interest in the water body. This step is concerned with how to bring the community into the aquatic plant management planning process.

Step D. Describe Water Body/Watershed Features.
A body of freshwater, such as a lake, pond or river, is a dynamic system that is influenced by physical, chemical and biological processes within it as well as by its surrounding watershed. Recognizing the interconnectedness of the two, integrated aquatic plant management takes a holistic approach in designing a management plan for a specific water body. An important step in the planning process is investigating background characteristics of the watershed and the water body to get a handle on what makes the system tick.

Step E. Identify Beneficial Use Areas.
Lakes, ponds, reservoirs, and rivers are *resources* in the truest sense of the word, serving human needs and providing habitat and food for wildlife. This step focuses on identifying beneficial uses of a water body, and presenting these uses graphically in a *Water Body Use Map.*

Step F. Map Aquatic Plants.
A management program designed to control nuisance growth of aquatic plants involves determining the types, location and relative abundance of the plants. This step consists of performing an aquatic plant survey of a water body. In completing this step it is important to be able to recognize general plant groups, collect samples for accurate identification, and produce an ***Aquatic Plant Map*** of the water body.

Step G. Characterize Aquatic Plants.
This step translates the information generated from the survey in Step F into a description of general plant zones in the water body. It identifies specific problem plant areas as well as beneficial plant zones.

Phase II (Control Strategies Development)

Step H. Investigate Control Alternatives.
A variety of methods (physical, mechanical, chemical, and biological) are currently available for control of nuisance aquatic plants to protect beneficial uses of a water body. This step describes each control alternative in terms of its effectiveness, advantages, drawbacks, costs, required permits, and status for use in Washington.

Step I. Specify Control Intensity.
An important aspect of integrated aquatic plant management is determining the right levels of control. This step looks at different control intensities appropriate for a water body, and results in construction of a simple ***Control Intensity Map.***

Step J. Choose Integrated Treatment Scenario.
This step of the process identifies critical factors for choosing the combination of control methods that best meets the needs of water-body users with the least impacts to the environment. This step is the nitty-gritty of the planning process, producing the basic treatment scenario(s) upon which the long-term management plan will be built in Step K.

Step K. Develop Action Program.
The final task of the planning process is to combine the pieces of information generated from the preceding steps and formulate a long-term action plan for aquatic plant management in a water body. Important components of the plan include in-lake treatment scenario, program costs/budget and funding mechanisms, monitoring and evaluation, public outreach, exotic weed prevention strategies, and formulating both short- and long-term action programs.

LAKE TWELVE INTEGRATED AQUATIC PLANT MANAGEMENT PLAN (IAPMP)

2nd PROJECT STEERING COMMITTEE MEETING

Date: Monday, June 27, 1994

Time: 4:00 to 7:00 PM

Place: Dick Hansen's property
27221 SE 306th Street
Black Diamond

AGENDA

1.	Project Update	4:00 - 4:15 PM
2.	Comments on Draft Problem Statement, Management Goals, and Beneficial Uses	4:15 - 4:30 PM
3.	Field Work Training	4:30 - 7:00 PM

This project is funded in part through a Washington State Department of Ecology Aquatic Weeds Management Fund grant.

King County
Surface Water Management Division
Department of Public Works
700 Fifth Avenue Suite 2200
Seattle, WA 98104
(206) 296-6519
(206) 296-0192 FAX

July 19, 1994

TO: Lake Twelve Steering Committee

FS FM: Fran Solomon, Ph.D., Senior Limnologist, Water Quality Unit

RE: Meeting Notes

Enclosed are the notes from the second Lake Twelve Steering Committee meeting. **Boldface text indicates updated information since the meeting.** Thanks to Dick and Toni Hanson for hosting the meeting and providing refreshments. Thanks to everyone for your comments on the project and milfoil signs that will be posted at the public boat launch and for volunteering to assist Maribeth Gibbons with aquatic plant mapping and sampling.

The next Steering Committee meeting will take place in the fall after the field work on the lake is complete. I will be in touch with everyone later this summer to determine the meeting date and agenda. Meanwhile, feel free to contact me at 296-1924 if you have any questions about the Lake Twelve Integrated Aquatic Plant Management Plan (IAPMP) project.

FS:pr
AW5:MM2

Enclosures

cc: Bill Eckel, Manager, Water Quality Unit

2nd **LAKE TWELVE IAPMP PROJECT STEERING COMMITTEE MEETING NOTES**
June 27, 1994 4:00 to 6:30 PM, Dick and Toni Hanson's house

Attendees at the second Steering Committee meeting included committee members and other members of the Lake Twelve Association who were interested in assisting the project consultant with aquatic plant mapping and sampling this summer. After general introductions, Fran Solomon announced that the Washington Department of Ecology has increased the maximum amount of money available for Aquatic Weeds Management Fund grants from $20,000 to $40,000. The King County Surface Water Management (SWM) Division requested and received an additional $9,400 for the Lake Twelve Integrated Aquatic Plant Management Plan (IAPMP) project. The additional money will fund more extensive field work and public involvement activities. The U.S. Environmental Protection Agency has recently approved a labelling change in the herbicide Sonar. Starting in 1995, it will be possible to use Sonar in waterbodies with potable water.

King County SWM has drafted two signs for installation on the existing posts at the Lake Twelve public boat launch: a sign announcing that the IAPMP project is underway, and a sign warning boaters to prevent the spread of milfoil by removing plant fragments from boats and trailers. Fran circulated copies of the draft signs and requested comments by July 8.

Esko Cate liked the picture of the swimmer in the milfoil sign. Dave Carter proposed yellow and black as colors for the milfoil sign. Toni Hanson proposed red for the background, green for the milfoil, and blue for the water. Dick Hanson suggested a stop sign rather than a warning sign, but said this was not a strong preference. Other committee members said that either image was satisfactory. Fran explained that a stop sign might appear accusatory, i.e. boaters are guilty of spreading milfoil around, whereas a warning sign emphasizes prevention rather than blame.

The milfoil sign will have a warning symbol and will be blue and green - blue for the water and green for the milfoil - with a white background. SWM's Signage Specialist pointed out that three colors would be too busy and too costly. The signs will be produced at King County and will be ready for installation by the middle of August.

Fran announced that she has spoken with the Washington Department of Fish and Wildlife (WDFW) about the need for a Port-A-Potty at the public boat launch. She was informed that a Port-A-Potty had been installed for public use during the first month of fishing season when the fishing season was deemed busiest, but was removed at the end of the month. Steering Committee members said that a Port-A-Potty should be retained throughout the fishing season. **Fran recontacted WDFW to discuss this. Unfortunately, WDFW does not have enough money in their budget to retain a Port-A-Potty at any public boat launch throughout the entire fishing season.**

(2nd) Meeting Notes

The SWM Lakes Program has recently acquired rakes and cutters for aquatic weed control. Fran offered to make these available to Lake Twelve property owners. The Steering Committee said that many people already have this equipment.

Dave commented that there is a lot of algae in the lake this year. Maribeth explained that both algae and milfoil survived through the unusually mild winter.

Maribeth asked for comments from the group on the draft problem statement, management goals, and waterbody beneficial uses map which were discussed at the first Steering Committee meeting. The group said that the draft was comprehensive and accurate. These documents will be part of the Lake Twelve IAPMP. Maribeth wants to indicate the location of water intakes on the waterbody uses map. Carolyn Carter said that almost everyone has water intakes. Esko offered to indicate these locations on a property owners' map and send this map to Maribeth.

Maribeth showed aerial photos of Lake Twelve taken over the past thirty years. Increased development on the lake shoreline is obvious from the photos. Esko commented that there was a resort on the lake in the 1930s and 1940s.

The remainder of today's meeting was devoted to training Steering Committee members and other volunteers in field techniques for measuring lake depth (bathymetry), identifying and mapping aquatic plants, and characterizing general sediment types in Lake Twelve. Maribeth recommended that the 1.2 miles of shoreline at Lake Twelve be divided into four survey segments of nearly equal lengths and that the volunteer survey be performed by at least four teams of two people per team. Maribeth will set up eight primary transect lines around the lake, i.e. lines that are perpendicular to shore and extend out to the 20 foot water depth mark. In each of the four zones, volunteers will set up six supplemental transects between the primary transects for a total of 24 supplemental transect lines.

Jeff Evans asked about project goals. Esko explained that the primary goal is to re-establish balance between water quality and aquatic plants. Some plants need to remain in the lake because they provide fish habitat and are sinks for nutrients; if there were no large plants in the lake, then there would be a lot of algae. Dave added that by developing an IAPMP, the Lake Twelve Association would be eligible to apply for an herbicide permit to control milfoil. The Lake Twelve Association would also be eligible to apply for funds to implement other aquatic plant management strategies.

Maribeth reviewed each of the tasks in the aquatic plant and bathymetric survey (for more details, see the handout that was distributed at the meeting). Meeting attendees will share the handouts and results of today's training with other prospective volunteers who were unable to attend the meeting.

Task 1 is to confirm the sampling dates and go through the equipment checklist. Maribeth demonstrated the use of an underwater viewer, a plexiglass-bottomed cone that can be used to view the bottom of lakes. Esko inquired if SWM has a similar device that can be loaned. SWM does not have such a device. Dave said that he will use snorkeling equipment to view the lake bottom.

(2nd) Meeting Notes

Task 2 is for each team to tour their segment of the shoreline and map the location of emergent and rooted, floating-leaved aquatic plants on a lake map. Dave proposed that everyone use the same legend to identify aquatic plants.

Task 3 is to find the physical location of each of 6 survey points marked on the lake map for each survey zone. At each survey point, the team needs to set up a transect line from shore out to the 20 foot water depth mark. The team would then take water depth measurements, plant samples, and notes of the sediment type at regular intervals along each transect line.

Maribeth showed the group a Secchi disk, which is used to measure lake transparency. Since the disk has a flat bottom, she will use it to locate the bottom of Lake Twelve for depth measurements.

Maribeth will sample aquatic plants in Lake Twelve on July 26, 27, and 28. Volunteers can sample on those dates or beforehand. Each team will need approximately 12 hours for each survey section and can choose how to divide the hours.

Task 4 involves collecting all data forms and plant samples for shipping to WATER Environmental Services, Maribeth's consulting firm. Carolyn offered to provide volunteers with waterproof paper for data sheets or to laminate the data sheets. If there are any questions about field sampling procedures, call Maribeth.

LAKE TWELVE INTEGRATED AQUATIC PLANT MANAGEMENT PROJECT
3rd STEERING COMMITTEE MEETING

Date: Wednesday, September 28, 1994

Time: 4:00 to 6:00 PM

Place: Esko Cate's house
27508 SE Green River Gorge Road
Black Diamond

AGENDA

1.	Announcements	4:00 - 4:05 PM
2.	Aquatic Plant Mapping and Sampling Results	4:05 - 5:05 PM
3.	Options for Water Source at Boat Launch for Washing Milfoil off Boats	5:05 - 5:50 PM
4.	Next Steps in Project	5:50 - 6:00 PM

This project is funded in part through a Washington State Department of Ecology Aquatic Weeds Management Fund grant.

prami2

King County
Surface Water Management Division
Department of Public Works
700 Fifth Avenue Suite 2200
Seattle, WA 98104
(206) 296-6519
(206) 296-0192 FAX

October 10, 1994

TO: Lake Twelve Steering Committee

FS FM: Fran Solomon, Ph.D., Senior Limnologist, Water Quality Unit

RE: Meeting Notes

Enclosed are the notes from the third Lake Twelve Steering Committee meeting. **Boldface text indicates updated information since the meeting.** Thanks to Esko Cate for hosting the meeting and providing refreshments. Thanks also to Esko, Carolyn Carter, and Dave Carter for suggesting designs for a water source at the public boat launch to wash milfoil off boats and trailers.

If you have any questions about the information in the notes, please call me at 296-1924. I look forward to seeing you at the public meeting on Thursday, October 13 at the Black Diamond Community Center.

Enclosures

cc: Bill Eckel, Manager, Water Quality Unit

3-1 **LAKE TWELVE INTEGRATED AQUATIC PLANT MANAGEMENT PROJECT**
STEERING COMMITTEE NOTES, September 28, 1994, 4:00 to 6:00 PM

Fran Solomon opened the meeting with several announcements. The educational sign about preventing the spread of milfoil and the general project sign have been completed. **Fran, Maribeth Gibbons, and Harry Gibbons checked the boat launch after today's meeting. The signs have been installed.**

The labelling requirements for the herbicide Rodeo have become more lenient. Rodeo can now be used in a potable body of water provided that everyone with water intakes is willing to shut off their intakes for 48 hours after the herbicide is applied.

The first public meeting on the Lake Twelve Integrated Aquatic Plant Management Project (IAPMP) will take place on Thursday, October 13 from 7:00 to 9:00 PM at the Black Diamond Community Center. Fran, Maribeth, and Harry will present an overview of the project, the results of this summer's aquatic plant inventory and viable techniques for managing nuisance aquatic plants in Lake Twelve. Over 600 people have received flyers about the meeting and a press release was mailed to local newspapers. The Washington Department of Fish and Wildlife and the Tulalip Tribe are on the mailing list. Fran will telephone the biologists at these agencies to encourage their attendance at the meeting.

Esko will write an article about the upcoming public meeting for the Lake Twelve Association newsletter, which will be mailed next week. **There is an excellent article in the newsletter.**

Fran distributed an article from the Wall Street Journal about milfoil problems in Massachusetts lakes. Thanks to Bill Kombol for calling the article to her attention. Fran also distributed membership forms for the Washington Lake Protection Association and flyers about SWM's 1995 Community Stewardship grants. Community groups are eligible to apply for grants to fund locally-initiated projects encouraging watershed protection, education, and restoration of lakes, wetlands, streams and rivers in King County. Proposals must be postmarked by December 15, 1994.

Fran requested a volunteer from the Lake Twelve community to monitor rainfall, lake level (weekly), and water clarity and temperature (monthly). Bill Kombol said that Pacific Coast Coal Company has a rainfall gauge. Fran will contact Mike Conabay to obtain the data. Carolyn and Dave Carter agreed to monitor the other parameters. They will use Esko's lake level gauge. Fran will send a Secchi disk and thermometer.

Fran distributed forms for recording volunteer hours on a monthly basis, retroactive to May, 1994. Field work, monitoring, attending Steering Committee and public meetings, and equipment purchased for these activities are all eligible contributors to

the in-kind local match ($12.50 per volunteer hour) on the Aquatic Weeds Management Fund grant.

Maribeth presented the aquatic plant inventory results. Eighteen species of aquatic plants were found, with white water lilies and Eurasian watermilfoil having the largest biomass. The aquatic plant map is dynamic, as distribution of plants varies from year to year. Maribeth is preparing voucher specimens of key plants on herbarium paper so that there will be a permanent record of types of aquatic plants in Lake Twelve in 1994. Plant biomass was less than that in lakes with severe aquatic plant problems (e.g. Green Lake), but milfoil biomass was greater than it had been at the time of the Phase I study and the biomass of other plants was comparable to that found in the Phase I study. Since we had a warm summer, it is likely that aquatic plant sampling in Lake Twelve occurred before the peak of the growing season. Nevertheless, the sampling results confirm visual observations of lakeside residents that the aquatic plant problem has worsened in the past 10 years.

Maribeth explained that reducing milfoil and water lilies in Lake Twelve will not mean obliteration of all plants in the lake. Harry said that aquatic plant management is a long-term endeavor. Esko requested that the term "nuisance plant" not be limited to exotic plants. There are native plants, e.g. watershield, that interfere with beneficial uses of Lake Twelve.

Bill recommended showing past and current summer aerial photos at the public meeting so that attendees can see the difference in the amount of plants on the lake. We will bring photos from 1960 and the present for contrast.

Maribeth discussed the beneficial uses map that she produced this summer. Most areas of the lake are used for swimming, fishing, and boating. A possible designation for the Palmer Coking Coal Company land is "conservancy area."

Maribeth and Harry summarized aquatic plant maangement techniques and pointed out that nontarget plants can also be affected by some actions. Harry also said that controlling milfoil and lilies in the lake will result in some increase in the amount of pondweed. The Steering Committee recommended that we present only viable options at the public meeting rather than discussing all options. These include physical controls (bottom barriers would be effective on a small scale), mechanical controls (resident-operated dredging), chemical controls (Sonar and Rodeo), and biological controls (grass carp). Dave pointed out the importance of presenting a menu of scenarios, not just saying "it's this method or that method."

Esko, Carolyn, and Dave presented ideas for a nonpotable water source at the public boat launch for washing milfoil off boats and trailers. One possibility is installing a "French drain" on the hill above the boat launch and capturing subsurface drainage. If there is insufficient flow during the dry season, a small storage tank could be installed to collect water for on-demand use. Another idea is to install a water intake in the lake and a pump for on-demand use. This would require eletric power where the pump is installed. An engineer at KCM, Inc. will review these ideas for feasibility and cost-effectiveness.

Based on the field work results, the discussion at Steering Committee meetings, and the discussion that will take place at the public meeting, Maribeth will write the draft Lake Twelve IAPMP. Steering Committee members are encouraged to phone suggestions to her at 842-9382.

The draft IAPMP will be out in mid-November and will be mailed to Steering Committee members and other interested parties for review. There will be a Steering Committee meeting on Tuesday, November 22 to discuss committee comments on the document. **Fran will contact Steering Committee members about the possibility of arranging a conference call for November 22. The second public meeting will take place on Tuesday, November 29 from 7:00 to 9:00 PM at the Black Diamond Community Center.** At this meeting, the public will be able to comment on the plan and a preferred aquatic plant management scenario or scenarios will be chosen. Following the meeting, there will be another two week review period for interested parties to send comments to Fran. The feasbility report on a water source at the boat launch for washing milfoil off boats and trailers will be out by mid-December and will be incorporated into the final IAPMP, which will be out by January 31, 1995. Fran asked Steering Committee members to send comments on the Citizens Manual for Developing Integrated Aquatic Vegetation Management Plans to her by the end of this year.

King County Department of Public Works

King County Surface Water Management
Everyone lives downstream

Public Meeting

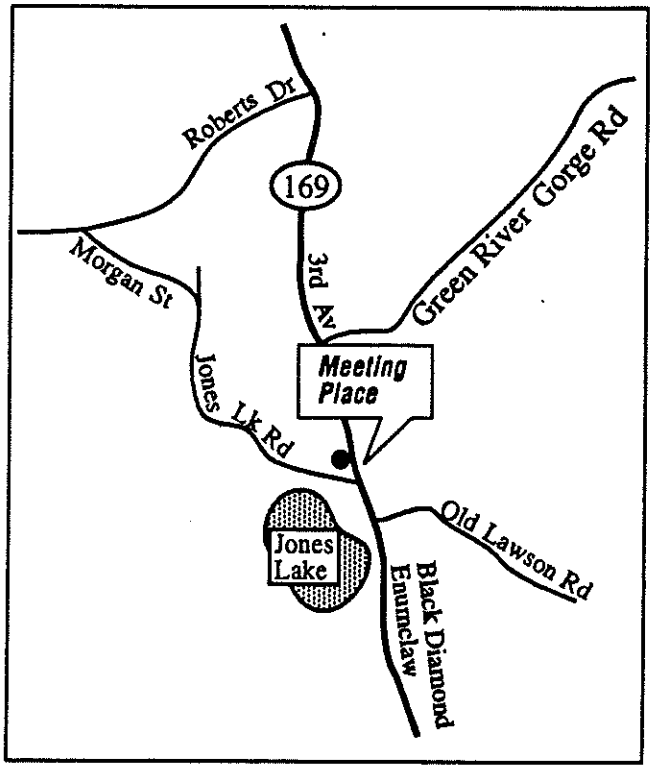
The King County Surface Water Management Division (SWM) invites you to a Public Meeting on the Lake Twelve Integrated Aquatic Plant Management Project. Come share your ideas about aquatic plant management for the lake.

Date: Thursday, October 13, 1994
7:00 PM - 9:00 PM

Location: Black Diamond Community Center
31605 Third Ave. (Hwy 169)
Black Diamond

Purpose of the Project: To determine quantity and diversity of aquatic plants in Lake Twelve, and develop an Integrated Aquatic Plant Management Plan (IAPMP) that balances water quality, recreational uses, and fish/wildlife habitat. The plan will include action strategies for both short and long-term aquatic plant management.

Status of the Project: Volunteers from the Lake Twelve community worked with the project consultant in surveying and sampling aquatic plants in the lake. A steering committee of lakeside property owners is working with SWM staff and the project consultant to develop a draft IAPMP for Lake Twelve. Results of this summer's Lake Twelve aquatic plant mapping/ sampling will be presented along with a discussion of available methods for aquatic plant control.



The public meeting will be an opportunity to meet County staff and consultants and learn more about the project.

We hope you can join us.

For more information: Call Fran Solomon, Senior Limnologist, at 296-1924.

Funded in part by a Washington State Department of Ecology Aquatic Weeds Management Fund grant.

Printed on recycled paper; please recycle.

Text will be made available in large print, Braille, or audio tape as requested.

King County Department of Public Works

King County Surface Water Management

Public Meeting

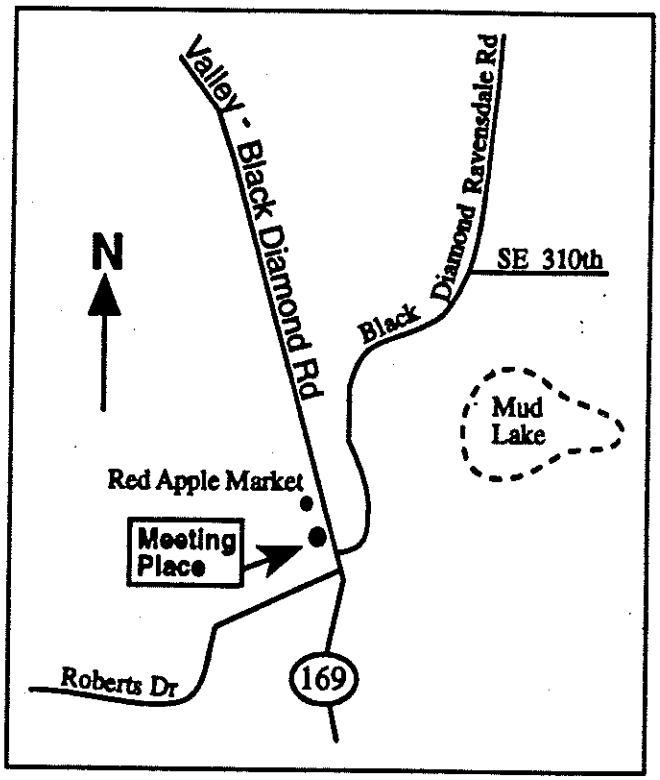
The King County Surface Water Management Division (SWM) invites you to a Public Meeting on the Lake Twelve Integrated Aquatic Plant Management Plan (IAPMP). Come share your ideas about aquatic plant management for the lake.

Date: Tuesday, November 29, 1994
7:00 PM - 9:00 PM

Location: Black Diamond Community Center
31605 Third Ave. (Hwy 169)
Black Diamond

Purpose of the Plan: To outline action strategies for both short and long-term aquatic plant management in Lake Twelve. The goal is to enhance water quality, beneficial uses, and fish and wildlife habitat for Lake Twelve by using nuisance plant control actions in ways that are both cost-effective and environmentally sensitive.

Status of the Plan: With input from the Lake Twelve community, a steering committee of lakeside property owners worked with SWM and the project consultant to develop a draft IAPMP for the lake. A summary of their proposed aquatic plant management options will be available two weeks prior to this public meeting. Those interested in submitting written comments on the plan, will have two weeks after the public meeting to do so. Comments will then be incorporated into the final plan, which will be produced by January 31, 1995.



The public meeting will be an opportunity to meet County staff and consultants and provide your input on aquatic plant management for Lake Twelve. We hope you can join us.

For more information or to receive a summary of the proposed options: Call Fran Solomon, Senior Limnologist, at 296-1924.

Funded in part by a Washington State Department of Ecology Aquatic Weeds Management Fund grant.

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Appendix B
Washington Natural Heritage Program Database Search of Lake Twelve Watershed

June 13, 1994

WASHINGTON STATE DEPARTMENT OF
Natural Resources

JENNIFER M. BELCHER
Commissioner of Public Lands
KALEEN COTTINGHAM
Supervisor

Fran Solomon
Surface Water Management Division
King County Public Works
700 Fifth Avenue - Suite 2200
Seattle WA 98104

SUBJECT: Lake Twelve Integrated Aquatic Plant Management Plan (T21N R06E S12 and T21N R07E S07)

We've searched the Natural Heritage Information System for information on significant natural features in your study area. Currently, we have no records for rare plants, high quality native wetlands or high quality native plant communities in the vicinity of your project.

The Washington Natural Heritage Program is responsible for information on the state's endangered, threatened, and sensitive plants as well as high quality native plant communities and wetlands. The Department of Fish and Wildlife manages and interprets data on wildlife species of concern in the state. For information on animals of concern in the state, please contact the Priority Habitats and Species Program, Washington Department of Fish and Wildlife, 600 Capitol Way North, Olympia, WA 98501-1091, or by phone (206) 753-3318.

The Natural Heritage Information System is not a complete inventory of Washington's natural features. Many areas of the state have never been thoroughly surveyed. There may be significant natural features in your study area that we don't yet know about. This response should not be regarded as a final statement on the natural features of the areas being considered and doesn't eliminate the need or responsibility for detailed on-site surveys.

I hope you'll find this information helpful.

Sincerely,

Sandy Norwood

Sandy Norwood, Environmental Review Coordinator
Washington Natural Heritage Program
Division of Forest Resources
PO Box 47047
Olympia WA 98504-7047
(206) 902-1667

Washington Dept. Fish and Wildlife - Wildlife Survey Data Management
Data Current as of June 8, 1994
Requested by KING_COUNTY for quad 4712231

Name: GREAT BLUE HERON SA Number: 122- 1 Criterion: B
Indexcode: DJ.371 State Status: SM Federal Status: TRS: T21N R06E S06 SEOFSE
Precision: LOCATION SHOWN ACCURATE TO 1/4 MI RADIUS & CONFIRMED BY WDG. Dtenter: 940214
Source of lead: WHALEN, MORIE - WDW Region: 4
Name of Area: Latlong: 471955N1220459W
Date of Sighting: 19920401 Quadcode: 4712231
Number of Owners: . Site Name: GRASS LAKE Quadname: BLACK DIAMOND
Name of Owner: County: KING
Agency Subsection: Ownership Code: PVTUUU
Protection Status: 3 Data Point #: 6 Special Status Code:
General Description: GREAT BLUE HERON COLONY IN MATURE 2ND GROWTH SWAMP MOSTLY HEMLOCK, CEDAR, COTTON WOOD, S OF GRASS LK. 8NESTS, 5-6 ACT;9NESTS-83; LK RESIDENTS RECALL SEEING YG & ADS CARRYING NESTING MATERIAL IN PAST. THOROUGH SEARCH FOUND NO NESTS-92;

Name: BALD EAGLE SA Number: 329- 2 Criterion: B
Indexcode: DF.416 State Status: ST Federal Status: FT TRS: T21N R06E S10 SWOFNW
Precision: LOCATION SHOWN ACCURATE TO 1/4 MI RADIUS & CONFIRMED BY WDG. Dtenter: 931019
Source of lead: THOMPSON, TRISH - WDW P.44 IN '93 SURVEY. Region: 4
Name of Area: Latlong: 471919N1220159W
Date of Sighting: 19930412 Quadcode: 4712231
Number of Owners: . Site Name: LAKE SAWYER Quadname: BLACK DIAMOND 7.5
Name of Owner: County: KING
Agency Subsection: Ownership Code: PVTUUU
Protection Status: . Data Point #: 10 Special Status Code:
General Description: BALD EAGLE NEST, LOCATED ON N SIDE OF RD, IN ONE OF 2 OLD TREES, STANDING ADJ. TO EACH OTHER. NEST #2 IS IN E TREE, ON W SIDE OF TRUNK, ABOUT 30FT FROM TOP.

Name: WESTERN POND TURTLE SA Number: 34- 1 Criterion: IO
Indexcode: CE.B43 State Status: SE Federal Status: FC2 TRS: T22N R06E S34 NWOFNE
Precision: LOCATION SHOWN ACCURATE TO 1/4 MI RADIUS & CONFIRMED BY WDG. Dtenter: 930525
Source of lead: FLATT, MARK (206-886-1089) P.1 IN '92 TURTLE SURVEY. Region: 4
Name of Area: Latlong: 472143N1220116W
Date of Sighting: 19920707 Quadcode: 4712231
Number of Owners: . Site Name: 4 CORNERS Quadname: BLACK DIAMOND 7.5
Name of Owner: County: KING
Agency Subsection: Ownership Code: PVTUUU
Protection Status: . Data Point #: 11 Special Status Code:
General Description: WESTERN POND TURTLE FOUND ALONG KENT KANGLEY RD 1/3RD MI W OF 4 CORNERS INTER-SECTION (MAPLE VALLEY HWY). SUB-ADULT, SEX UNKNOWN, 5YRS OLD. SENT TO WOODLAND PARK ZOO AFTER TAKEN FROM KID WHO PICKED IT UP (GEOFF FRASER 206-631-9261).

WASHINGTON DEPT OF WILDLIFE

PRIORITY HABITATS AND SPECIES
Tabular Data Report - General Information - DRAFT
06/08/1994

form: 901485 species/habitat: HIHI species use: B season: S definition: 4 map accuracy: 1
sitename: UPPER GREEN RIVER HARLEQUIN AREA
general description: HARLEQUIN BREEDING AREAS.

source: ROSEBROOK; USFS date: 051782 code: PROF
synopsis: 1 PAIR FEEDING IN RIVER BTWN 5430/5400 JUNCTION T20N R 10E S21

source: ROSEBROOK, D date: 052482 code: PROF
synopsis: 1 MALE ADULT SEEN 1 1/2 MILES W OF LESTER ON RD 212 T20N R10E S22 NW 1/4

source: RECHAID date: 051481 code: PROF
synopsis: 1 ADULT & 1 UNAGED SEEN ON RIVER IN GORGE T21N R7E S8

form: 902254 species/habitat: HALE species use: B season: SU definition: 4T map accuracy: 1
sitename: GREEN RIVER BALD EAGLE TERRITORY
general description: EAGLE TERRITORY IDENTIFIED IN 1990, ACTIVE BUT UNPRODUCTIVE IN 1990.

source: WATSON, JIM, WDW 1990 PERSONAL OBSERVATION date: 06 90 code: NEST
synopsis: BREEDING SURVEYS

form: 902275 species/habitat: CAVE species use: season: definition: 4 map accuracy: 1
sitename: LOWER GREEN RIVER GORGE COAL MINE.
general description: CAVE (ABANDONED COAL MINE SHAFT). SITE IS IN FLAMING GEYSER PARK.

source: ANONYMOUS, 1990, PERSONAL OBSERVATION. date: 07 90 code: LOCAL
synopsis: WILDLIFE AGENT, MIKE KRENZ, HAS VERIFIED SITE IN INTERVIEWS WITH LOCAL RESIDENTS

PRIORITY HABITATS AND SPECIES
Tabular Data Report - General Information - DRAFT
06/08/1994

form: 902538 species/habitat: WET species use: season: definition: 4 map accuracy: 1
sitename: SOOS CREEK WETLANDS
general description: VARIOUS WETLANDS IN THE SOOS CREEK DRAINAGE BASIN. MANY OF THESE ALSO HAVE AN OP
EN WATER COMPONENT.

source: KING COUNTY SENSITIVE AREAS MAPS. date: 12 90 code: GSMAP
synopsis: USGS BASED MAP SYSTEM WITH NWI INFORMATION.

form: 902539 species/habitat: WET species use: season: definition: 4 map accuracy: 1
sitename: GREEN RIVER WETLANDS (MIDDLE)
general description: VARIOUS WETLANDS DRAINING TO THE GREEN RIVER (MIDDLE SECTION-FLAMING GEYSER TO T
HE HEADWORKS). MANY OF THESE ALSO HAVE AN OPEN WATER COMPONENT.

source: KING COUNTY SENSITIVE AREAS MAPS. date: 12 90 code: GSMAP
synopsis: USGS BASED MAP SYSTEM USING NWI INFORMATION.

form: 902545 species/habitat: WET species use: season: definition: 4 map accuracy: 1
sitename: WHITE RIVER WETLANDS (LOWER RIVER-KING COUNTY).
general description: A VARIETY OF WETLANDS WITHIN THE LOWER WHITE RIVER DRAINAGE BASIN (DOWNSTREAM FR
OM MUD MOUNTAIN DAM). MANY OF THESE SITES ALSO CONTAIN OPEN WATER COMPONENT.

source: KING COUNTY SENSITIVE AREAS MAPS. date: 12 90 code: GSMAP
synopsis: USGS QUAD. BASED MAPPING SYSTEM.

PRIORITY HABITATS AND SPECIES
Tabular Data Report - General Information - DRAFT
06/08/1994

form: 902640 species/habitat: UNOS species use: season: definition: 4 map accuracy: 1
sitename: GREEN RIVER VICINITY PARKS.
general description: EXTENSIVE STATE PARK SYSTEM ALONG THE GREEN RIVER. MOST OF THESE AREAS CONTAIN S TEEP CLIFFS AND RAVINES THAT ARE NOT DISTURBED BY HUMANS. PROVIDE REFUGIA AND MI GRATION WAYS FOR WILDLIFE.
source: MULLER, TED; WDW; PERSONAL OBSERVATIONS. date: 90 code: PROF
synopsis: AERIAL SURVEYS OF THIS AREA.

form: 902646 species/habitat: UNOS species use: season: definition: map accuracy: 0
sitename: GREEN RIVER VALLEY CANDIDATE OPEN SPACE AREAS.
general description: STEEP FORESTED HILL SLOPES ALONG THE GREEN RIVER VALLEY. THESE AREAS ARE UNSTABL E BUT PROVIDE WILDLIFE HABITAT AND MIGRATION CORRIDORS.

source: MULLER, TED; WDW; PERSONAL OBSERVATIONS. date: 90 code: PROF
synopsis: MANY DRIVE-BYS AND AERIAL OVERFLIGHTS DURING PAST 16 YRS.

form: 902790 species/habitat: WAFO species use: RLC season: W definition: 4 map accuracy: 1
sitename: LAKES WITH WATERFOWL USE;KING/SNOHOMISH COUNTIES
general description: LOWLAND LAKES WHICH PROVIDE A FOOD BASE FOR PISCIVOROUS AND HERBIVOROUS WATERFOW L IN WINTER. WESTERN GREBES, MERGANSERS, CORMORANTS, COOTS, AND CANADA GEESE ARE MOST NUMEROUS.
source: CROPP, TOM AND CURT KRAEMER, WDW; PERSONAL OBSERVATIONS date: 90 code: PROF
synopsis: FISHERIES BIOLOGISTS REPORT OBSERVING HEAVY PREDATION OF BOTH PLANTED AND WILD F ISH IN THESE WATERS-NOVEMBER THROUGH MARCH.

PRIORITY HABITATS AND SPECIES
Tabular Data Report - General Information - DRAFT
06/08/1994

form: 902803 species/habitat: RIPAR species use: season: definition: 4 map accuracy: 1
sitename: GREEN RIVER RIPARIAN AREAS.
general description: FORESTED AREAS ALONG THE RIVERBANKS.

source: MULLER, TED, WDW; PERSONAL OBSERVATIONS. date: 90 code: PROF
synopsis: MANY DRIVE-BYS AND AERIAL SURVEYS DURING PAST 16 YEARS.

form: 903627 species/habitat: HALE species use: B season: SU definition: 4T map accuracy: 1
sitename: LAKE SAWYER
general description: EAGLE TERRITORY IDENTIFIED IN 1991 ACTIVE AND PRODUCTIVE

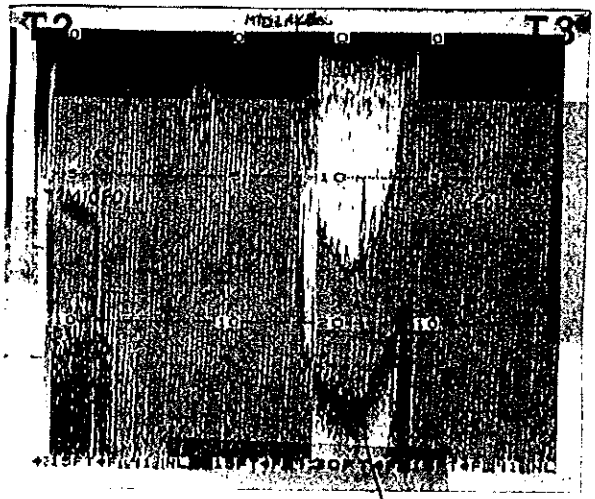
source: WATSON, JIM 1991 PERSTONAL OBSERVATIONS. date: 06 91 code: NEST
synopsis: BREEDING SURVEYS

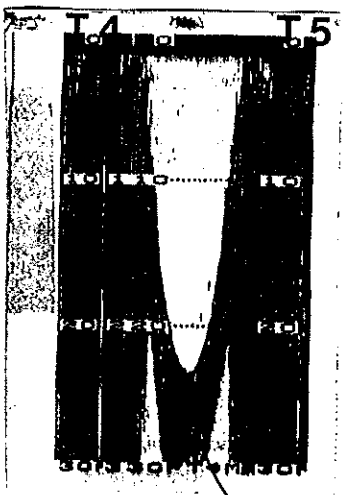
form: 903654 species/habitat: HALE species use: B season: SU definition: 4T map accuracy: 1
sitename: GREEN RIVER EAGLE TERRITORY.
general description: EAGLE TERRITORY IDENTIFIED IN 1990; ACTIVE

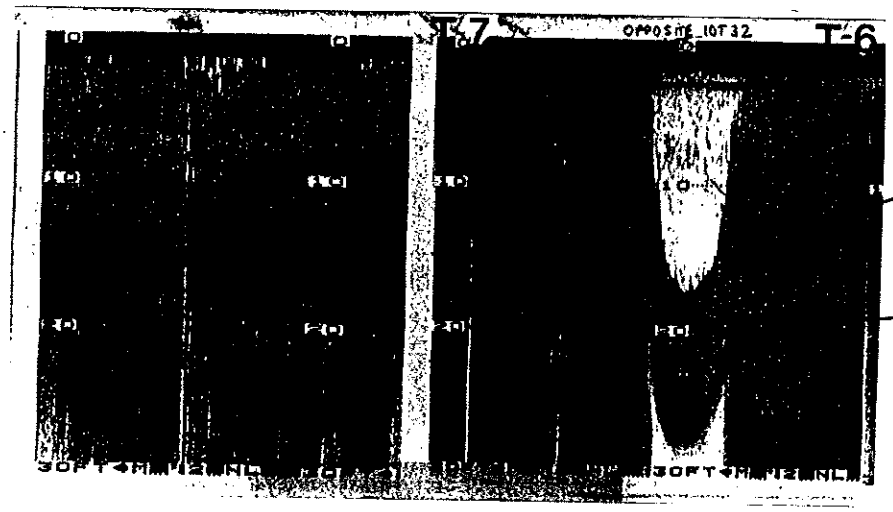
source: WATSON JIM, WDW, 1990, PERSONAL OBSERVATIONS. date: 06 90 code: NEST
synopsis: BREEDING SURVEYS.

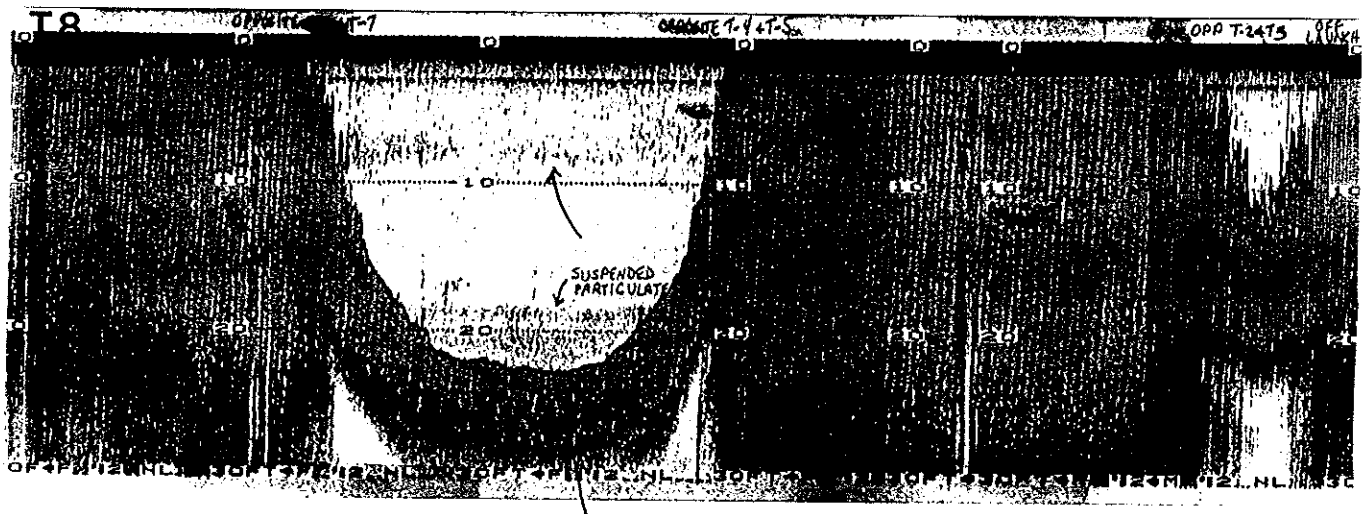
Appendix C
1994 Lake Twelve Aquatic Plant Survey
Fathometer Recordings

LAKE TWELVE FATHOMETER RECORDINGS
ALONG PRIMARY TRANSECTS
JULY 1994 SURVEY









Appendix D
Manufacturer Labels
for SONAR® and RODEO®

Specimen Label

Herbicide

A herbicide for management of aquatic vegetation in fresh water ponds, lakes, reservoirs, drainage canals and irrigation canals

Active Ingredient:
fluridone: 1-methyl-3-phenyl-5-[3-(trifluoromethyl)phenyl]-4(1*H*)-pyridinone..... 41.7%
Inert Ingredients..... 58.3%
Total.....100.0%
Contains 4 pounds active ingredient per gallon.

EPA Reg. No. 67690-4

Precautionary Statements

Hazards to Humans and Domestic Animals

Keep Out of Reach of Children

CAUTION PRECAUCION

Precaucion al usuario: Si usted no lee inglés, no use este producto hasta que la etiqueta le haya sido explicada ampliamente.

Harmful If Swallowed, Absorbed Through Skin, Or If Inhaled

Avoid breathing of spray mist or contact with skin, eyes, or clothing. Wash thoroughly with soap and water after handling. Wash exposed clothing before reuse.

First Aid

If in eyes: Flush eyes or skin with plenty of water. Get medical attention if irritation persists.
If swallowed: Call a physician or poison control center, drink one or two glasses of water and induce vomiting by touching back of throat with finger. Do not induce vomiting or give anything by mouth to an unconscious person.
If inhaled: Remove victim to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. Get medical attention.

Environmental Hazards

Follow use directions carefully so as to minimize adverse effects on nontarget organisms. In order to avoid impact on threatened or endangered aquatic plant or animal species, users must consult their State Fish and Game Agency or the U.S. Fish and Wildlife Service before making applications.

Do not contaminate water when disposing of equipment washwaters. Trees and shrubs growing in water treated with Sonar A.S. herbicide may occasionally develop chlorosis. Do not apply in tidewater/brackish water.

Lowest rates should be used in shallow areas where the water depth is considerably less than the average depth of the entire treatment site, for example, shallow shoreline areas.

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
Read all Directions for Use carefully before applying.
Shake well before using.

Storage and Disposal

Do not contaminate water, food, or feed by storage or disposal.
Storage: Store in original container only. Do not store near feed or foodstuffs. In case of leak or spill, use absorbent materials to contain liquids and dispose as waste.
Pesticide Disposal: Wastes resulting from use of this product may be used according to label directions or disposed of at an approved waste disposal facility.
Container Disposal: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

*Trademark of SePRO Corporation

Sonar® A.S. Herbicide

General Information

Sonar A.S. herbicide is a selective systemic aquatic herbicide for management of aquatic vegetation in fresh water ponds, lakes, reservoirs, drainage canals and irrigation canals. Sonar A.S. is absorbed from water by plant shoots and from hydrosoil by the roots of aquatic vascular plants. It is important to maintain the recommended concentration of Sonar A.S. in contact with the weeds as long as possible. Rapid water movement or any condition which results in rapid dilution of Sonar A.S. in treated water will reduce its effectiveness. In susceptible plants, Sonar A.S. inhibits the formation of carotene. In the absence of carotene, chlorophyll is rapidly degraded by sunlight. Herbicidal symptoms of Sonar A.S. appear in seven to ten days and appear as white (chlorotic) or pink growing points. Under optimum conditions 30 to 90 days are required before the desired level of aquatic weed management is achieved with Sonar A.S. Species susceptibility to Sonar A.S. may vary depending on time of year, stage of growth, and water movement. For best results, apply Sonar A.S. prior to initiation of weed growth or when weeds begin active growth.

Sonar A.S. is not corrosive to application equipment.

General Use Precautions

Obtain Required Permits: Consult with appropriate state or local water authorities before applying this product. Permits may be required by state or local public agencies.

Chemigation: Do not apply Sonar A.S. through any type of irrigation system.

Potable Water Intakes: In lakes and reservoirs, do not apply Sonar A.S. within one-fourth mile (1320 feet) of any functioning potable water intake. **Note: Existing potable water intakes which are no longer in use, such as those replaced by potable water wells or connections to a municipal water system, are not considered to be functioning potable water intakes.**

Irrigation: Irrigation with water treated with Sonar A.S. may result in injury to the irrigated vegetation. SePRO recommends informing those who irrigate from areas treated with Sonar A.S. of the irrigation time frames presented in the table below. These time frames are suggestions which should be followed to reduce the potential for injury to vegetation irrigated with water treated with Sonar A.S.:

Application Site	Days After Application		
	Established Tree Crops	Established Row Crops Turf/Plants	Newly Seeded Crops/Seedbeds or Areas to be Planted Including /Overseeded Golf Course Greens
†Ponds and Static Canals	7	30	30
Canals	7	14	30
††Lakes and Reservoirs	7	14	14

†For purposes of Sonar A.S. labeling, a pond is defined as a body of water 10 acres or less in size. A lake or reservoir is greater than 10 acres.

††In lakes and reservoirs where one-half or greater of the body of water is treated, use the pond and static canal irrigation restrictions.

Weed Control Information

Vascular Aquatic Plants Controlled by Sonar A.S.

Floating Plants:

Common duckweed (*Lemna minor*)†

Emersed Plants:

spatterdock (*Nuphar luteum*)
water-lily (*Nymphaea* spp.)

†Controlled only with a surface application of Sonar AS.

Submersed Plants:

bladderwort (*Utricularia* spp.)
common coontail (*Ceratophyllum demersum*)
common elodea (*Elodea canadensis*)
egeria, Brazilian elodea (*Egeria densa*)
fanwort, cabomba (*Cabomba caroliniana*)
hydrilla (*Hydrilla verticillata*)
naiad (*Najas* spp.)
pondweed (*Potamogeton* spp., except Illinois pondweed)
watermilfoil (*Myriophyllum* spp.)

Shoreline Grasses:

paragrass (*Brachiaria mutica*)

Vascular Aquatic Plants Partially Controlled by Sonar A.S.

alligatorweed (*Alternanthera philoxeroides*)
American lotus (*Nelumbo lutea*)
cattail (*Typha* spp.)
common watermeal (*Wolffia columbiana*)††
creeping waterprimrose (*Ludwigia peploides*)
giant cutgrass (*Zizaniopsis miliacea*)
Illinois pondweed (*Potamogeton illinoensis*)
parrotfeather (*Myriophyllum brasiliense*)
reed canarygrass (*Phlaris arundinaceae*)
smartweed (*Polygonum* spp.)
spikerush (*Eleocharis* spp.)
southern watergrass (*Hydrochloa caroliniensis*)
torpedograss (*Panicum repens*)
waterpurslane (*Ludwigia palustris*)
watershield (*Brasenia schreberi*)

††Partial control only with a surface application of Sonar A.S. at the maximum labeled rate.

Vascular Aquatic Plants Not Controlled by Sonar A.S.

algae (*Chara* and *Nitella*)
American frogbit (*Limnobium spongia*)
arrowhead (*Sagittaria* spp.)
bacopa (*Bacopa* spp.)
big floatingheart, banana lily (*Nymphoides aquatica*)
bulrush (*Scirpus* spp.)
floating waterhyacinth (*Eichhornia crassipes*)
maidencane (*Panicum hemitomon*)
pickerelweed, lanceleaf (*Pontederia cordata*)
rush (*Juncus* spp.)
tapegrass, American eelgrass (*Vallisneria americana*)
waterlettuce (*Pistia stratiotes*)
water pennywort (*Hydrocotyle umbellata*)

Mixing and Application Directions

The aquatic plants present in the treatment site should be identified prior to application to determine their susceptibility to Sonar A.S. It is important to determine the area (acres) to be treated and the average depth in order to select the proper application rate. Do not exceed the maximum labeled rate for a given treatment site per annual growth cycle.

Shake Sonar A.S. well before using. Add the recommended amount of Sonar A.S. to water in the spray tank during the filling operation. Agitate while filling and during spraying. Surface or subsurface application of the spray can be made with conventional spray equipment. Sonar A.S. can also be applied near the surface of the hydrosoil using weighted trailing hoses. A spray volume of 5 to 100 gallons per acre may be used. Sonar A.S. may also be diluted with water and the concentrated mix metered into the pumping system.

Application to Ponds

Sonar A.S. may be applied to the entire surface area of a pond. Rates may be selected to provide 0.06 to 0.09 ppm of active ingredient in the treated water. Application rates necessary to obtain these active ingredient concentrations in treated water are shown in the following table. When average water depth of the treatment site is greater than 5 feet, apply 1 to 1.5 quarts of Sonar A.S. per treated surface acre.

Average Water Depth of Treatment Site (feet)	Quarts of Sonar A.S. per Treated Surface Acre
1	0.16 - 0.25
2	0.33 - 0.50
3	0.50 - 0.75
4	0.65 - 1.00
5	0.80 - 1.25

Use the higher rate within the rate range where there is a dense weed mass or when treating more difficult to control species.

Application to Lakes and Reservoirs

For best results in lakes and reservoirs, Sonar A.S. treatment areas should be a minimum of 5 acres in size. Treatment of areas smaller than 5 acres or treatment of narrow strips such as boat lanes or shorelines may not produce satisfactory results due to dilution by untreated water. In lakes and reservoirs, do not apply Sonar A.S. within one-fourth mile (1320 feet) of any functioning potable water intake.

Rates may be selected to provide 0.075 to 0.15 ppm of active ingredient in the treated water. Application rates necessary to obtain these active ingredient concentrations in treated water are shown in the following table. When average water depth of the treatment site is greater than 10 feet, apply 3 to 4 quarts of Sonar A.S. per treated surface acre.

Average Water Depth of Treatment Site (feet)	Quarts of Sonar A.S. per Treated Surface Acre
1	0.2 - 0.4
2	0.4 - 0.8
3	0.6 - 1.2
4	0.8 - 1.6
5	1.0 - 2.0
6	1.2 - 2.4
7	1.4 - 2.8
8	1.6 - 3.2
9	1.8 - 3.6
10	2.0 - 4.0

Use the higher rate within the rate range where there is a dense weed mass or when treating more difficult to control species.

Use Rates for Control of Eurasian Watermilfoil in Whole Lake or Reservoir Treatments: The following application rates may be used for control of Eurasian watermilfoil when treating lakes or reservoirs where little dilution with untreated water is expected to occur. Under these conditions, Sonar may be applied to provide a concentration of 0.01 to 0.02 ppm (10 to 20 ppb) of active ingredient in treated water. Application rates necessary to achieve these active ingredient concentrations in treated water are shown in the following table. For optimum control, it is recommended that applications be made early in the growing season.

Average Water Depth of Treatment Site (feet)	Quarts of Sonar A.S. per Treated Surface Acre
1	0.027 - 0.05
2	0.05 - 0.11
3	0.08 - 0.16
4	0.11 - 0.22
5	0.14 - 0.27
6	0.16 - 0.32
7	0.19 - 0.38
8	0.22 - 0.43
9	0.24 - 0.49
10	0.27 - 0.54

When treated with these use rates, other less susceptible species listed under Aquatic Plants Controlled may exhibit only temporary injury or stunting followed by recovery and normal growth. These 0.01 to 0.02 ppm rates may be applied where functioning potable water intakes are present. Note: When applications for management of Eurasian watermilfoil are made to only portions of lakes or reservoirs such as bays or fingers of these water bodies, the higher rates and use directions listed on this label for Applications to Lakes and Reservoirs are recommended.

Application Rate Calculation - Ponds, Lakes and Reservoirs

The amount of Sonar A.S. to be applied to provide the desired ppm concentration of active ingredient in treated water may be calculated as follows:

Quarts of Sonar A.S. required per treated surface acre = Average water depth of treatment site (feet) x Desired ppm concentration of active ingredient x 2.7

For example, the quarts per acre of Sonar A.S. required to provide a concentration of 0.075 ppm of active ingredient in water with an average depth of 5 feet is calculated as follows:

5 x 0.075 x 2.7 = 1.0 quart per treated surface acre.

When measuring quantities of Sonar A.S., quarts may be converted to fluid ounces by multiplying quarts to be measured x 32. For example, 0.25 quarts x 32 = 8 fluid ounces.

Note: Calculated rates should not exceed the maximum allowable rate in quarts per treated surface acre for the water depth listed in the application rate table for the site to be treated.

Application to Drainage Canals and Irrigation Canals

In drainage and irrigation canals, Sonar A.S. should be applied at the rate of 2 quarts per treated surface acre. Where water retention is possible, the performance of Sonar A.S. will be enhanced by restricting water flow. In moving bodies of water, use an application pattern that will provide a uniform distribution and avoid concentration of the herbicide.

Warranty Disclaimer

SePRO Corporation warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. SEPRO CORPORATION MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

Inherent Risks of Use

It is impossible to eliminate all risks associated with use of this product. Plant injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label, such as unfavorable temperatures, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of SePRO Corporation or the seller. All such risks shall be assumed by Buyer.

Limitation of Remedies

The exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories), shall be limited to, at SePRO's election, one of the following:

(1) Refund of purchase price paid by buyer or use for product bought, or
(2) Replacement of amount of product used.

SePRO Corporation shall not be liable for losses or damages resulting from handling or use of this product unless SePRO Corporation is promptly notified of such loss or damage in writing. In no case shall SePRO Corporation be liable for consequential or incidental damages or losses.

The terms of the Warranty Disclaimer above and this Limitation of Remedies cannot be varied by any written or verbal statements or agreements. No employee or sales agent of SePRO Corporation or the seller is authorized to vary or exceed the terms of the Warranty Disclaimer or this Limitation of Remedies in any manner.

This sample label is current as of February 15, 1995. The product descriptions and recommendations provided in this sample label are for background information only. Always refer to the label on the product before using Monsanto or any other agrichemical product.

RODEO

EMERGED AQUATIC WEED AND BRUSH HERBICIDE

BY Monsanto

Complete Directions for Use In Aquatic and Other Noncrop Sites.

EPA Reg. No. 524-343

AVOID CONTACT WITH FOLIAGE, GREEN STEMS, EXPOSED NONWOODY ROOTS, OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, SINCE SEVERE INJURY OR DESTRUCTION MAY RESULT.

1995-1 21061T1-L/CG

Read the entire label before using this product.

Use only according to label instructions.

Read "LIMIT OF WARRANTY AND LIABILITY" before buying or using. If terms are not acceptable, return at once unopened.

REFORMULATION IS PROHIBITED. SEE INDIVIDUAL CONTAINER LABEL FOR REPACKAGING LIMITATIONS.

LIMIT OF WARRANTY AND LIABILITY

This Company warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes set forth in the Complete Directions for Use label booklet ("Directions") when used in accordance with those Directions under the conditions described therein. NO OTHER EXPRESS WARRANTY OR IMPLIED WARRANTY OF FITNESS FOR PARTICULAR PURPOSE OR MERCHANTABILITY OR ANY OTHER EXPRESS OR IMPLIED WARRANTY IS MADE. This warranty is also subject to the conditions and limitations stated herein.

Buyer and all users shall promptly notify this Company of any claims whether based in contract, negligence, strict liability, other tort or otherwise.

Buyer and all users are responsible for all loss or damage from use or handling which results from conditions beyond the control of this Company, including, but not limited to, incompatibility with products other than those set forth in the Directions, application to or contact with desirable vegetation, unusual weather, weather conditions which are outside the range considered normal at the application site and for the time period when the product is applied, as well as weather conditions which are outside the application ranges set forth in the Directions, application in any manner not explicitly set forth in the Directions, moisture conditions outside the moisture range specified in the Directions, or the presence of products other than those set forth in the Directions in or on the soil or treated vegetation.

THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE LIMIT OF THE LIABILITY OF THIS COMPANY OR ANY OTHER SELLER FOR ANY AND ALL LOSSES, INJURIES OR DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT (INCLUDING CLAIMS BASED IN CONTRACT, NEGLIGENCE, STRICT LIABILITY, OTHER TORT OR OTHERWISE) SHALL BE THE PURCHASE PRICE PAID BY THE USER OR BUYER FOR THE QUANTITY OF THIS PRODUCT INVOLVED, OR, AT THE ELECTION OF THIS COMPANY OR ANY OTHER SELLER, THE REPLACEMENT OF SUCH QUANTITY, OR, IF NOT ACQUIRED BY PURCHASE, REPLACEMENT OF SUCH QUANTITY. IN NO EVENT SHALL THIS COMPANY OR ANY OTHER SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL, OR SPECIAL DAMAGES.

Buyer and all users are deemed to have accepted the terms of this LIMIT OF WARRANTY AND LIABILITY which may not be varied by any verbal or written agreement.

PRECAUTIONARY STATEMENTS

Hazards to Humans and Domestic Animals

Keep out of reach of children.

CAUTION!

HARMFUL if INHALED

Avoid breathing vapors or spray mist.

Remove contaminated clothing and wash clothing before reuse.

Wash thoroughly with soap and water after handling.

FIRST AID: IF INHALED, remove individual to fresh air. Seek medical attention if breathing difficulty develops.

In case of an emergency involving this product, Call Collect, day or night, (314) 694-4000.

Environmental Hazards

Do not contaminate water when disposing of equipment washwaters. Treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants. This oxygen loss can cause fish suffocation.

In case of SPILL or LEAK, soak up and remove to a landfill.

Physical or Chemical Hazards

Spray solutions of this product should be mixed, stored and applied using only stainless steel, aluminum, fiberglass, plastic and plastic-lined steel containers.

DO NOT MIX, STORE OR APPLY THIS PRODUCT OR SPRAY SOLUTIONS OF THIS PRODUCT IN GALVANIZED STEEL OR UNLINED STEEL (EXCEPT STAINLESS STEEL) CONTAINERS OR SPRAY TANKS. This product or spray solutions of this product react with such containers and tanks to produce hydrogen gas which may form a highly combustible gas mixture. This gas mixture could flash or explode, causing serious personal injury, if ignited by open flame, spark, welder's torch, lighted cigarette or other ignition source.

ACTIVE INGREDIENT:	
*Glyphosate, N-(phosphonomethyl)glycine, in the form of its isopropylamine salt	53.8%
INERT INGREDIENTS:	46.2%
	100.0%

*Contains 648 grams per litre or 5.4 pounds per U.S. gallon of the active ingredient, glyphosate, in the form of its isopropylamine salt. Equivalent to 480 grams per litre or 4 pounds per U.S. gallon of the acid, glyphosate.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in any manner inconsistent with its labeling.

For more product information, call toll-free 1-800-332-3111.

Storage and Disposal

Do not contaminate water, foodstuffs, feed or seed by storage or disposal.

See container label for STORAGE AND DISPOSAL instructions.

GENERAL INFORMATION

This product, a water-soluble liquid, mixes readily with water and nonionic surfactant to be applied as a foliar spray for the control or destruction of many herbaceous and woody plants.

This product moves through the plant from the point of foliage contact to and into the root system. Visible effects on most annual weeds occur within 2 to 4 days but on most perennial brush species may not occur for 7 days or more. Extremely cool or cloudy weather following treatment may slow the activity of this product and delay visual effects of control. Visible effects are a gradual wilting and yellowing of the plant which advances to complete browning of above-ground growth and deterioration of underground plant parts.

Unless otherwise directed on this label, delay application until vegetation has emerged and reached the stages described for control of such vegetation under the "Weeds Controlled" section of this label.

Unemerged plants arising from unattached underground rhizomes or root stocks of perennials or brush will not be affected by the spray and will continue to grow. For this reason best control of most perennial weeds or brush is obtained when treatment is made at late growth stages approaching maturity.

Always use the higher rate of this product per acre within the recommended range when vegetation is heavy or dense.

Prepare the desired volume of spray solution by mixing the amount of this product in water shown in the following table.

Spray Solution

DESIRED VOLUME	AMOUNT OF RODEO®					
	3/4%	1%	1¼%	1½%	5%	8%
1 gallon	1 oz.	1 oz.	1 oz.	2 oz.	6 oz.	10 oz
25 gallons	1¼ pt.	1 qt.	1¼ qt.	1½ qt.	5 qt.	2 gal.
100 gallons	3 qt.	1 gal	1¼ gal.	1½ gal.	5 gal	8 gal

2 tablespoons = 1 ounce

For use in knapsack sprayers it is suggested that the recommended amount of this product be mixed with water in a larger container. Fill sprayer with the mixed solution and add the correct amount of surfactant.

WEEDS CONTROLLED

ANNUAL WEEDS

Apply to actively growing annual grasses and broadleaf weeds.

Allow at least 3 days after application before disturbing treated vegetation. After this period the weeds may be mowed, tilled or burned. See "Directions for Use," "General Information" and "Mixing and Application Instructions" for labeled uses and specific application instructions.

Broadcast Application—Use 1 1/2 pints of this product per acre plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution if weeds are less than 6 inches tall. If weeds are greater than 6 inches tall, use 2 1/2 pints of this product per acre plus 2 or more quarts of an approved nonionic surfactant per 100 gallons of spray solution.

Hand-Held, High-Volume Application—Use a 3/4 percent solution of this product in water plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution and apply to foliage of vegetation to be controlled.

When applied as directed under the conditions described in this label, this product plus nonionic surfactant WILL CONTROL the following ANNUAL WEEDS:

Balsamapple**
Momordica charantia

Barley
Hordeum vulgare

Barnyardgrass
Echinochloa crus-galli

Bassia, fivehook
Bassia hyssopifolia

Bluegrass, annual
Poa annua

Bluegrass, bulbous
Poa bulbosa

Brome
Bromus spp.

Buttercup
Ranunculus spp.

Chart
Bromus secalinus

Chickweed, mouseear
Cerastium vulgatum

Cocklebur
Xanthium strumarium

Corn, volunteer
Zea mays

Crabgrass
Digitaria spp

Dwarfdandelion
Krigia cespitosa

Falseflax, smallseed
Camelina microcarpa

Fiddleneck
Amsinckia spp.

Fleabane, annual
Conyza bonariensis

Fleabane
Erigeron spp.

Foxtail
Setaria spp.

Foxtail, Carolina
Alopecurus carolinianus

Groundsel, common
Senecio vulgaris

Horseweed/Marestail
Conyza canadensis

Kochia
Kochia scoparia

Lambsquarters, common
Chenopodium album

Lettuce, prickly
Lactuca serriola

Morningglory
Ipomoea spp.

Mustard, blue
Chorispora tenella

Mustard, tansy
Descurainia pinnata

Mustard, tumble
Sisymbrium altissimum

Mustard, wild
Sinapis arvensis

Oats, wild
Avena fatua

Panicum
Panicum spp.

Pennycress, field
Thlaspi arvense

Pigweed, redroot
Amaranthus retroflexus

Pigweed, smooth
Amaranthus hybridus

Ragweed, common
Ambrosia artemisiifolia

Ragweed, giant
Ambrosia trifida

Rocket, London
Sisymbrium irio

Rye
Secale cereale

Ryegrass, Italian*
Lolium multiflorum

Sandbur, field
Cenchrus spp

Shattercane
Sorghum bicolor

Shepherdspurse
Capsella bursa-pastoris

Signalgrass, broadleaf
Brachiaria platyphylla

Smartweed, Pennsylvania
Polygonum pensylvanicum

Sowthistle, annual
Sonchus oleraceus

Spanishneedles*
Bidens bipinnata

Stinkgrass
Eragrostis cilianensis

Sunflower
Helianthus annuus

Thistle, Russian
Salsola kali

Spurry, umbrella
Holosteum umbellatum

Velvetleaf
Abutilon theophrasti

Wheat
Triticum aestivum

Witchgrass
Panicum capillare

*Apply 3 pints of this product per acre

**Apply with hand-held equipment only.

Annual weeds will generally continue to germinate from seed throughout the growing season. Repeat treatments will be necessary to control later germinating weeds.

PERENNIAL WEEDS

Apply this product as follows to control or destroy most vigorously growing perennial weeds. Unless otherwise directed, allow at least 7 days after application before disturbing vegetation.

Add 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution to the rates of this product given in this list. See the "General Information," "Directions for Use" and "Mixing and Application" sections in this label for specific uses and application instructions.

NOTE: If weeds have been mowed or tilled, do not treat until regrowth has reached the recommended stages. Fall treatments must be applied before a killing frost.

Repeat treatments may be necessary to control weeds regenerating from underground parts or seed.

When applied as recommended under the conditions described, this product plus surfactant WILL CONTROL the following PERENNIAL WEEDS:

Alfalfa
Medicago sativa

Alligatorweed*
Alternanthera philoxeroides

Anise/Fennel
Foeniculum vulgare

Artichoke, Jerusalem
Helianthus tuberosus

Bahiagrass
Paspalum notatum

Bermudagrass
Cynodon dactylon

Bindweed, field
Convolvulus arvensis

Bluegrass, Kentucky
Poa pratensis

Blowout, Texas
Helianthus ciliaris

Bracken fern
Pteridium spp.

Brome grass, smooth
Bromus inermis

Canarygrass, reed
Phalaris arundinacea

Cattail
Typha spp.

Clover, red
Trifolium pratense

Clover, white
Trifolium repens

Cogongrass
Imperata cylindrica

Cordgrass
Spartina spp.

Cutgrass, giant*
Zizaniopsis miliacea

Dallisgrass
Paspalum dilatatum

Dandelion
Taraxacum officinale

Dock, curly
Rumex crispus

Dogbane, hemp
Apocynum cannabinum

Fescue
Festuca spp

Fescue, tall
Festuca arundinacea

Guineagrass
Panicum maximum

Hemlock, poison
Conium maculatum

Horsenettle
Solanum carolinense

Horseradish
Armoracia rusticana

Ice Plant
Mesembryanthemum crystallinum

Johnsongrass
Sorghum halepense

Kikuyugrass
Pennisetum clandestinum

Knapweed
Centaurea repens

Lantana
Lantana camara

Lespedeza: common, sericea
Lespedeza striata
Lespedeza cuneata

Loosestrife, purple
Lythrum salicaria

Lotus, American
Nelumbo lutea

Maidencane
Panicum hematomon

Milkweed
Asclepias spp.

Muhly, wirestem
Muhlenbergia frondosa

Mullein, common
Verbascum thapsus

Napiergrass
Pennisetum purpureum

Nightshade, silverleaf
Solanum elaeagnifolium

Nutsedge: purple, yellow
Cyperus rotundus
Cyperus esculentus

Orchardgrass
Dactylis glomerata

Pampasgrass
Cortaderia jubata

Paragrass
Brachiaria mutica

Phragmites**
Phragmites spp.

Quackgrass
Agropyron repens

Reed, giant
Arundo donax

Ryegrass, perennial
Lolium perenne

Smartweed, swamp
Polygonum coccineum

Spatterdock
Nuphar luteum

Starthistle, yellow
Centaurea solstitialis

Sweet potato, wild*
Ipomoea pandurata

Thistle, artichoke
Cynara cardunculus

Thistle, Canada
Cirsium arvense

Timothy
Phleum pratense

Torpedograss*
Panicum repens

Tules, common
Scirpus acutus

Vaseygrass
Paspalum urvillei

Velvetgrass
Holcus spp.

Waterhyacinth
Eichornia crassipes

Waterlettuce
Pistia stratiotes

Waterprimrose
Ludwigia spp.

Wheatgrass, western
Agropyron smithii

*Partial control.

**Partial control in southeastern states. See specific recommendations below.

Alligatorweed—Apply 6 pints of this product per acre as a broadcast spray or as a 1 1/4 percent solution with hand-held equipment to provide partial control of alligatorweed. Apply when most of the target plants are in bloom. Repeat applications will be required to maintain such control.

Bermudagrass—Apply 7 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and when seed heads appear.

Bindweed, field/Silverleaf Nightshade/Texas Blueweed—Apply 6 to 7 1/2 pints of this product per acre as a broadcast spray west of the Mississippi River and 4 1/2 to 6 pints of this product per acre east of the Mississippi River. With hand-held equipment, use a 1 1/2 percent solution. Apply when target plants are actively growing and are at or beyond full bloom. For silverleaf nightshade, best results can be obtained when application is made after berries are formed. Do not treat when weeds are under drought stress. New leaf development indicates active growth. For best results apply in late summer or fall.

Bracken fern—Apply 4 1/2 to 6 pints of this product per acre as a broadcast spray or as a 3/4 to 1 percent solution with hand-held equipment. Apply to fully expanded fronds which are at least 18 inches long.

Cattail—Apply 4 1/2 to 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and are at or beyond the early-to-full bloom stage of growth. Best results are achieved when application is made during the summer or fall months.

Cogongrass—Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray. Apply when cogongrass is at least 18 inches tall and actively growing in late summer or fall. Allow 7 or more days after application before tillage or mowing. Due to uneven stages of growth and the dense nature of vegetation preventing good spray coverage, repeat treatments may be necessary to maintain control.

Cordgrass—Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 to 2 percent solution with hand-held equipment. Schedule applications in order to allow 6 hours before treated plants are covered by tidewater. The presence of debris and silt on the cordgrass plants will reduce performance. It may be necessary to wash targeted plants prior to application to improve uptake of this product into the plant.

Cutgrass, giant—Apply 6 pints of this product per acre as a broadcast spray or as a 1 percent solution with hand-held equipment to provide partial control of giant cutgrass. Repeat applications will be required to maintain such control, especially where vegetation is partially submerged in water. Allow for substantial regrowth to the 7 to 10-leaf stage prior to retreatment.

Dogbane, hemp/Knapweed/Horseradish—Apply 6 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud-to-flower stage of growth. For best results, apply in late summer or fall.

Fescue, tall—Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 1 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot-to-head stage of growth. When applied prior to the boot stage, less desirable control may be obtained.

Guineagrass—Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and when most have reached at least the 7-leaf stage of growth.

Johnsongrass/Bluegrass, Kentucky/Bromegrass, smooth/Canarygrass, reed/Orchardgrass/Ryegrass, perennial/Timothy/Wheatgrass, western—Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot-to-head stage of growth. When applied prior to the boot stage, less desirable control may be obtained. In the fall, apply before plants have turned brown.

Lantana—Apply this product as a 3/4 to 1 percent solution with hand-held equipment. Apply to actively growing lantana at or beyond the bloom stage of growth. Use the higher application rate for plants that have reached the woody stage of growth.

Loosestrife, purple—Apply 4 pints of this product per acre as a broadcast spray or as a 1 to 1 1/2 percent solution using hand-held equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost.

Lotus, American—Apply 4 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost. Repeat treatment may be necessary to control regrowth from underground parts and seeds.

Maidencane/Paragrass—Apply 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Repeat treatments will be required, especially in vegetation partially submerged in water. Under these conditions, allow for regrowth to the 7 to 10-leaf stage prior to retreatment.

Milkweed, common—Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud-to-flower stage of growth.

Nutsedge: purple, yellow—Apply 4 1/2 pints of this product per acre as a broadcast spray, or as a 3/4 percent solution with hand-held equipment to control existing nutsedge plants and immature nutlets attached to treated plants. Apply when target plants are in flower or when new nutlets can be found at rhizome tips. Nutlets which have not germinated will not be controlled and may germinate following treatment. Repeat treatments will be required for long-term control.

Pampasgrass—Apply a 1 1/2 percent solution of this product with hand-held equipment when plants are actively growing.

Phragmites—For partial control of phragmites in Florida and the counties of other states bordering the Gulf of Mexico, apply 7 1/2 pints per acre as a broadcast spray or apply a 1 1/2 percent solution with hand-held equipment. In other areas of the U.S., apply 4 to 6 pints per acre as a broadcast spray or apply a 3/4 percent solution with hand-held equipment for partial control. For best results, treat during late summer or fall months when plants are actively growing and in full bloom. Due to the dense nature of the vegetation, which may prevent good spray coverage and uneven stages of growth, repeat treatments may be necessary to maintain control. Visual control symptoms will be slow to develop.

Quackgrass/Kikuyugrass/Muhly, wirestem—Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment when most quackgrass or wirestem muhly is at least 8 inches in height (3 to 4-leaf stage of growth) and actively growing. Allow 3 or more days after application before tillage.

Reed, giant/Ice plant—For control of giant reed and ice plant, apply a 1 1/2 percent solution of this product with hand-held equipment when plants are actively growing. For giant reed, best results are obtained when applications are made in late summer to fall.

Spatterdock—Apply 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when most plants are in full bloom. For best results, apply during the summer or fall months.

Sweet potato, wild—Apply this product as a 1 1/2 percent solution using hand-held equipment. Apply to actively growing weeds that are at or beyond the bloom stage of growth. Repeat applications will be required. Allow the plant to reach the recommended stage of growth before retreatment.

Thistle: Canada, artichoke—Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment for Canada thistle. To control artichoke thistle, apply a 2 percent solution as a spray-to-wet application. Apply when target plants are actively growing and are at or beyond the bud stage of growth.

Torpedograss—Apply 6 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment to provide partial control of torpedograss. Use the lower rates under terrestrial conditions, and the higher rates under partially submerged or a floating mat condition. Repeat treatments will be required to maintain such control.

Tules, common—Apply this product as a 1 1/2 percent solution with hand-held equipment. Apply to actively growing plants at or beyond the seedhead stage of growth. After application, visual symptoms will be slow to appear and may not occur for 3 or more weeks.

Waterhyacinth—Apply 5 to 6 pints of this product per acre as a broadcast spray or apply a 3/4 to 1 percent solution with hand-held equipment. Apply when target plants are actively growing and at or beyond the early bloom stage of growth. After application, visual symptoms may require 3 or more weeks to appear with complete necrosis and decomposition usually occurring within 60 to 90 days. Use the higher rates when more rapid visual effects are desired.

Waterlettuce—For control, apply a 3/4 to 1 percent solution of this product with hand-held equipment to actively growing plants. Use higher rates where infestations are heavy. Best results are obtained from mid-summer through winter applications. Spring applications may require retreatment.

Waterprimrose—Apply this product as a 3/4 percent solution using hand-held equipment. Apply to plants that are actively growing at or beyond the bloom stage of growth, but before fall color changes occur. Thorough coverage is necessary for best control.

Other perennials listed on this label—Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached early head or early bud stage of growth.

WOODY BRUSH AND TREES

When applied as recommended under the conditions described, this product plus surfactant CONTROLS or PARTIALLY CONTROLS the following woody brush plants and trees:

Alder
Alnus spp.

Ash*
Fraxinus spp.

Aspen, quaking
Populus tremuloides

Bearclover, Bearmat
Chamaebatia foliolosa

Birch
Betula spp.

Blackberry
Rubus spp.

Broom:
French
Cytisus monspessulanus
Scotch
Cytisus scoparius

Buckwheat, California*
Eriogonum fasciculatum

Cascara*
Rhamnus purshiana

Catsclaw*
Acacia greggi

Ceanothus
Ceanothus spp.

Chamise
Adenostoma fasciculatum

Cherry:
Bitter
Prunus emarginata
Black
Prunus serotina
Pin
Prunus pensylvanica

Coyote brush
Baccharis consanguinea

Creeper, Virginia*
Parthenocissus quinquefolia

Dewberry
Rubus trivialis

Dogwood
Cornus spp.

Elderberry
Sambucus spp.

Elm*
Ulmus spp.

Eucalyptus, bluegum
Eucalyptus globulus

Hasardia*
Haplopappus squarrosus

Hawthorn
Crataegus spp.

Hazel
Corylus spp.

Hickory
Carya spp.

Holly, Florida, Brazilian Peppertree
Schinus terebinthifolius

Honeysuckle
Lonicera spp.

Hornbeam, American
Carpinus caroliniana

Kudzu
Pueraria lobata

Locust, black*
Robinia pseudoacacia

Manzanita
Arctostaphylos spp.

Maple:
Red**
Acer rubrum
Sugar
Acer saccharum
Vine*
Acer circinatum

Monkey Flower*
Mimulus guttatus

Oak:
Black*
Quercus velutina
Northern pine
Quercus palustris
Post
Quercus stellata
Red
Quercus rubra
Southern red
Quercus falcata
White*
Quercus alba

Persimmon*
Diospyros spp.

Poison ivy
Rhus radicans

Poison Oak
Rhus toxicodendron

Poplar, yellow*
Liriodendron tulipifera

Prunus
Prunus spp.

Raspberry
Rubus spp.

Redbud, eastern
Cercis canadensis

Rose, multiflora
Rosa multiflora

Russian-olive
Elaeagnus angustifolia

Sage: black, white
Salvia spp.

Sagebrush, California
Artemisia californica

Salmonberry
Rubus spectabilis

Salt cedar*
Tamarix spp.

Saltbush, Sea myrtle
Baccharis halimifolia

Sassafras
Sassafras albidum

Sourwood*
Oxydendrum arboreum

Sumac:
Poison*
Rhus vernix
Smooth*
Rhus glabra
Winged*
Rhus copallina

Sweet gum
Liquidambar styraciflua

Swordfern*
Polystichum munitum

Tallowtree, Chinese
Sapium sebiferum

Thimbleberry
Rubus parviflorus

Tobacco, tree*
Nicotiana glauca

Trumpetcreeper
Campsis radicans

Waxmyrtle, southern*
Myrica cerifera

Willow
Salix spp.

*Partial control

**See below for control or partial control instruction.

NOTE: If brush has been mowed or tilled or trees have been cut, do not treat until regrowth has reached the recommended stage of growth.

Apply the recommended rate of this product plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution when plants are actively growing and, unless otherwise directed, after full-leaf expansion. Use the higher rate for larger plants and/or dense areas of growth. On vines, use the higher rate for plants that have reached the woody stage of growth. Best results are obtained when application is made in late summer or fall after fruit formation.

In arid areas, best results are obtained when application is made in the spring or early summer when brush species are at high moisture content and are flowering. Ensure thorough coverage when using hand-held equipment. Symptoms may not appear prior to frost or senescence with fall treatments.

Allow 7 or more days after application before tillage, mowing or removal. Repeat treatments may be necessary to control plants regenerating from underground parts or seed. Some autumn colors on undesirable deciduous species are acceptable provided no major leaf drop has occurred. Reduced performance may result if fall treatments are made following a frost.

See the "Directions for Use" and "Mixing and Application Instructions" sections in this label for labeled use and specific application instructions.

Applied as a 5 to 8 percent solution as a directed application as described in the "HAND-HELD AND HIGH-VOLUME EQUIPMENT" section, this product will control or partially control all species listed in this section of this label. Use the higher rate of application for dense stands and larger woody brush and trees.

Apply the product as follows to control or partially control the following woody brush and trees:

Alder/Blackberry/Dewberry/Honeysuckle/Oak, Post/Raspberry—For control, apply 4 1/2 to 6 pints per acre as a broadcast spray or as a 3/4 to 1 1/4 percent solution with hand-held equipment.

Aspen, Quaking/Hawthorn/Trumpetcreeper—For control, apply 3 to 4 1/4 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/4 percent solution with hand-held equipment.

Birch/Elderberry/Hazel/Salmonberry/Thimbleberry—For control, apply 3 pints per acre of this product as a broadcast spray or as a 3/4 percent solution with hand-held equipment.

Broom: French, Scotch—For control apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment.

Buckwheat, California/Hazardia/Monkey Flower/Tobacco, Tree—For partial control of these species apply a 3/4 to 1 1/2 percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results.

Catclaw—For partial control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.

Cherry: Bitter, Black, Pin/Oak, Southern Red/Sweet Gum/Prunus—For control, apply 3 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 to 1 1/2 percent solution with hand-held equipment.

Coyote brush—For control apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.

Dogwood/Hickory/Salt cedar—For partial control, apply a 1 to 2 percent solution of this product with hand-held equipment or 6 to 7 1/2 pints per acre as a broadcast spray.

Eucalyptus, bluegum—For control of eucalyptus resprouts, apply a 1 1/2 percent solution of this product with hand-held equipment when resprouts are 6 to 12-feet tall. Ensure complete coverage. Apply when plants are actively growing. Avoid application to drought-stressed plants.

Holly, Florida/Wax myrtle, southern—For partial control, apply this product as a 1 1/2 percent solution with hand-held equipment.

Kudzu—For control, apply 6 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Repeat applications will be required to maintain control.

Maple, Red—For control, apply as a 3/4 to 1 1/4 percent solution with hand-held equipment when leaves are fully developed. For partial control, apply 2 to 7 1/2 pints of this product per acre as a broadcast spray.

Maple, Sugar/Oak: Northern Pin, Red—For control, apply as a 3/4 to 1 1/4 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.

Poison Ivy/Poison Oak—For control, apply 6 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Repeat applications may be required to maintain control. Fall treatments must be applied before leaves lose green color.

Rose, multiflora—For control, apply 3 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Treatments should be made prior to leaf deterioration by leaf-feeding insects.

Sage, black/Sagebrush, California/Chamise/Tallewtree, Chinese—For control of these species, apply a 3/4 percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results.

Saltbush, Sea myrtle—For control, apply this product as a 1 percent solution with hand-held equipment.

Willow—For control, apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment.

Other woody brush and trees listed in this label—For partial control, apply 3 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment.

AQUATIC AND OTHER NONCROP SITES

When applied as directed and under the conditions described in the "Weeds Controlled" section in this label, this product will control or partially control the labeled weeds growing in the following industrial, recreational and public areas or other similar aquatic and terrestrial sites.

Aquatic Sites—This product may be applied to emerged weeds in all bodies of fresh and brackish water which may be flowing, nonflowing or transient. This includes lakes, rivers, streams, ponds, estuaries, rice levees, seeps, irrigation and drainage ditches, canals, reservoirs, wastewater treatment facilities, wildlife habitat restoration and management areas and similar sites.

If aquatic sites are present in the noncrop area and are part of the intended treatment, read and observe the following directions:

This product does not control plants which are completely submerged or have a majority of their foliage under water.

There is no restriction on the use of treated water for irrigation, recreation or domestic purposes.

Consult local state fish and game agency and water control authorities before applying this product to public water. Permits may be required to treat such water.

NOTE: Do not apply this product within 1/2 mile up-stream of an active potable water intake in flowing water (i.e., river, stream, etc.) or within 1/2 mile of an active potable water intake in a standing body of water such as lake, pond or reservoir. To make aquatic applications around and within 1/2 mile of active potable water intakes, the water intake must be turned off for a minimum period of 48 hours after the application. The water intake may be turned on prior to 48 hours if the glyphosate level in the intake water is below 0.7 part per million as determined by laboratory analysis. These aquatic applications may be made ONLY in those cases where there are alternative water sources or holding ponds which would permit the turning off of an active potable water intake for a maximum period of 48 hours after the applications.

For treatments after drawdown of water or in dry ditches, allow 7 or more days after treatment before reintroduction of water to achieve maximum weed control. Apply this product within 1 day after drawdown to ensure application to actively growing weeds.

Floating mats of vegetation may require retreatment. Avoid wash-off of sprayed foliage by spray boat or recreational boat backwash or by rainfall within 6 hours of application. Do not re-treat within 24 hours following the initial treatment.

Applications made to moving bodies of water must be made while traveling upstream to prevent concentration of this herbicide in water. When making any bankside applications, do not overlap more than 1 foot into open water. Do not spray in bodies of water where weeds do not exist. The maximum application rate of 7 1/2 pints per acre must not be exceeded in any single broadcast application that is being made over water.

When emerged infestations require treatment of the total surface area of impounded water, treating the area in strips may avoid oxygen depletion due to decaying vegetation. Oxygen depletion may result in fish kill.

Other Noncrop-Type Sites—This product may be used to control the listed weeds in terrestrial noncrop sites and/or in aquatic sites within these areas.

Airports	Petroleum Tank Farms
Golf Courses	Pipeline, Power, Telephone & Utility Rights-of-Way
Habitat Restoration & Management Areas	Pumping Installations
Highways & Roadsides	Railroads
Industrial Plant Sites	Schools
Lumberyards	Storage Areas
Parking Areas	Similar Sites
Parks	

WILDLIFE HABITAT RESTORATION AND MANAGEMENT AREAS

This product is recommended for the restoration and/or maintenance of native habitat and in wildlife management areas.

Habitat Restoration and Maintenance—When applied as directed, exotic and other undesirable vegetation may be controlled in habitat management areas. Applications may be made to allow recovery of native plant species, to open up water to attract waterfowl, and for similar broad-spectrum vegetation control requirements in habitat management areas. Spot treatments may be made to selectively remove unwanted plants for habitat enhancement. For spot treatments, care should be exercised to keep spray off of desirable plants.

Wildlife Food Plots—This product may be used as a site preparation treatment prior to planting wildlife food plots. Apply as directed to control vegetation in the plot area. Any wildlife food species may be planted after applying this product, or native species may be allowed to reinfest the area. If tillage is needed to prepare a seedbed, wait 7 days after applying this product before tilling to allow for maximum effectiveness.

WIPER APPLICATIONS

For wick or wiper applications, mix 1 gallon of this product with 2 gallons of clean water to make a 33 percent solution. Addition of a nonionic surfactant at a rate of 10 percent by volume of total herbicide solution is recommended.

Water applications can be used to control or suppress annual and perennial weeds listed on this label. In heavy weed stands a double application in opposite directions may improve results. See the "Weeds Controlled" section of this label for recommended treated growth stage and other instructions for achieving optimum results.

CUT STUMP APPLICATION

Woody vegetation may be controlled by treating freshly cut stumps of trees and resprouts with this product. Apply this product using suitable equipment to ensure coverage of the entire cambium. Cut vegetation close to the soil surface. Apply a 50 to 100 percent solution of this product to freshly cut surface immediately after cutting. Delay in applying this product may result in reduced performance. For best results, trees should be cut during periods of active growth and full leaf expansion.

When used according to directions for cut stump application this product will CONTROL, PARTIALLY CONTROL or SUPPRESS most woody brush and tree species, some of which are listed below:

Alder *Alnus spp.*	Poplar* *Populus spp.*
Coyote brush* *Baccharis consanguinea*	Reed, giant *Arundo donax*
Dogwood* *Cornus spp.*	Salt cedar *Tamarix spp.*
Eucalyptus *Eucalyptus spp.*	Sweet gum* *Liquidambar styraciflua*
Hickory* *Carya spp.*	Sycamore* *Platanus occidentalis*
Madrone *Arbutus menziesii*	Tan oak *Lithocarpus densiflorus*
Maple* *Acer spp.*	Willow *Salix spp.*
Oak *Quercus spp.*	

*This product is not approved for this use on these species in the state of California.

INJECTION AND FRILL APPLICATIONS

Woody vegetation may be controlled by injection or frill application of this product. Apply this product using suitable equipment which must penetrate into living tissue. Apply the equivalent of 1 ml of this product per 2 to 3 inches of trunk diameter. This is best achieved by applying 25 to 100 percent concentration of this product either to a continuous frill around the tree or as cuts evenly spaced around the tree below all branches. As tree diameter increases in size, better results are achieved by applying dilute material to a continuous frill or more closely spaced cuttings. Avoid application techniques that allow runoff to occur from frill or cut areas in species that exude sap freely after frills or cutting. In species such as these, make frill or cut at an oblique angle so as to produce a cupping effect and use undiluted material. For best results, applications should be made during periods of active growth and full leaf expansion.

This treatment WILL CONTROL the following woody species:

Oak *Quercus spp.*	Sweet gum *Liquidambar styraciflua*
Poplar *Populus spp.*	Sycamore *Platanus occidentalis*

This treatment WILL SUPPRESS the following woody species:

Black gum* *Nyssa sylvatica*	Hickory *Carya spp.*
Dogwood *Cornus spp.*	Maple, red *Acer rubrum*

*This product is not approved for this use on this species in the state of California.

RELEASE OF BERMUDAGRASS OR BAHIAGRASS ON NONCROP SITES

RELEASE OF DORMANT BERMUDAGRASS AND BAHIAGRASS

When applied as directed, this product will provide control or suppression of many winter annual weeds and tall fescue for effective release of dormant bermudagrass or bahiagrass. Make applications to dormant bermudagrass or bahiagrass.

For best results on winter annuals, treat when weeds are in an early growth stage (below 6 inches in height) after most have germinated. For best results on tall fescue, treat when fescue is in or beyond the 4 to 6-leaf stage.

WEEDS CONTROLLED

Rate recommendations for control or suppression of winter annuals and tall fescue are listed below.

Apply the recommended rates of this product in 10 to 25 gallons of water per acre plus 2 quarts nonionic surfactant per 100 gallons of total spray volume.

WEEDS CONTROLLED OR SUPPRESSED*

NOTE: C = Control
S = Suppression

WEED SPECIES	RODEO® FLUID OZ/ACRE 6	9	12	18	24	48
Barley, little *Hordeum pusillum*	S	C	C	C	C	C
Bedstraw, catchweed *Galium aparine*	S	C	C	C	C	C
Bluegrass, annual *Poa annua*	S	C	C	C	C	C
Chervil *Chaerophyllum tainturieri*	S	C	C	C	C	C
Chickweed, common *Stellaria media*	S	C	C	C	C	C
Clover, crimson *Trifolium incarnatum*	•	S	S	C	C	C
Clover, large hop *Trifolium campestre*	•	S	S	C	C	C
Speedwell, corn *Veronica arvensis*	S	C	C	C	C	C
Fescue, tall *Festuca arundinacea*	•	•	•	•	S	S
Geranium, Carolina *Geranium carolinianum*	•	•	S	S	C	C
Henbit *Lamium amplexicaule*	•	S	C	C	C	C
Ryegrass, Italian *Lolium multiflorum*	•	•	S	C	C	C
Vetch, common *Vicia sativa*	•	•	S	C	C	C

*These rates apply only to sites where an established competitive turf is present.

RELEASE OF ACTIVELY GROWING BERMUDAGRASS

NOTE: USE ONLY ON SITES WHERE BAHIAGRASS OR BERMUDAGRASS ARE DESIRED FOR GROUND COVER AND SOME TEMPORARY INJURY OR YELLOWING OF THE GRASSES CAN BE TOLERATED.

When applied as directed, this product will aid in the release of bermudagrass by providing control of annual species listed in the "Weeds Controlled" section in this label, and suppression or partial control of certain perennial weeds.

For control or suppression of those annual species listed in this label, use 3/4 to 2 1/4 pints of this product as a broadcast spray in 10 to 25 gallons of spray solution per acre, plus 2 quarts of a nonionic surfactant per 100 gallons of total spray volume. Use the lower rate when treating annual weeds below 6 inches in height (or length of runner in annual vines). Use the higher rate as size of plants increases or as they approach flower or seedhead formation.

Use the higher rate for partial control or longer-term suppression of the following perennial species. Use lower rates for shorter-term suppression of growth.

Bahiagrass	Johnsongrass**
Dallisgrass	Trumpetcreeper*
Fescue (tall)	Vaseygrass

*Suppression at the higher rate only.
**Johnsongrass is controlled at the higher rate.

Use only on well-established bermudagrass. Bermudagrass injury may result from the treatment but regrowth will occur under worst conditions. Repeat applications in the same season are not recommended, since severe injury may result.

BAHIAGRASS SEEDHEAD AND VEGETATIVE SUPPRESSION

When applied as directed in the "Noncrop Sites" section in this label, this product will provide significant inhibition of seedhead emergence and will suppress vegetative growth for a period of approximately 45 days with single applications and approximately 120 days with sequential applications.

Apply this product 1 to 2 weeks after full green-up of bahiagrass or after the bahiagrass has been mowed to a uniform height of 3 to 4 inches. Applications must be made prior to seedhead emergence. Apply 5 fluid ounces per acre of this product, plus 2 quarts of an approved nonionic surfactant per 100 gallons of total spray volume in 10 to 25 gallons of water per acre.

Sequential applications of this product plus nonionic surfactant may be made at approximately 45-day intervals to extend the period of seedhead and vegetative growth suppression. For continued vegetative growth suppression, sequential applications must be made prior to seedhead emergence.

Apply no more than 2 sequential applications per year. As a first sequential application, apply 3 fluid ounces of this product per acre plus nonionic surfactant. A second sequential application of 2 to 3 fluid ounces per acre plus nonionic surfactant may be made approximately 45 days after the last application.

ANNUAL GRASS GROWTH SUPPRESSION

For growth suppression of some annual grasses, such as annual ryegrass, wild barley and wild oats growing in coarse turf on roadsides or other industrial areas, apply 3 to 4 ounces of this product in 10 to 40 gallons of spray solution per acre. Mix 2 quarts of a nonionic surfactant per 100 gallons of spray solution. Applications should be made when annual grasses are actively growing and before the seedheads are in the boot stage of development. Treatments made after seedhead emergence may cause injury to the desired grasses.

Product is protected by U.S. Patent No. 4,405,531. Other patents are pending. No license granted under any non-U.S. patent(s).

EPA Reg. No. 524-343

In case of an emergency involving this product,
Call Collect, day or night, (314) 694-4000.

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MONSANTO COMPANY
AGRICULTURAL PRODUCTS
ST. LOUIS, MISSOURI, 63167 U.S.A.

Appendix E
Lake Twelve Boat Washing Cost Assessment
KCM, Inc.

BOAT WASHING ASSESSMENT

Water Source		Cost
Curtain Drain		
Drain	$3,000	
Line	6,000	
		$9,000
Lake		
Line with pump	$2,000	
Electricity	5,000	
		$7,000
Tank		
Storage tank	$3,000	
Pump (pressure) electricity	5,000	
		$8,000

TOTAL COST

Curtain Drain	**$17,000**
Lake	**$15,000**

ATTENDANCE LIST

Name	Address	Phone
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Bill Kombol	Palmer Coking Coal Company P.O. Box 10 Black Diamond	886-2841
Carolyn & Dave Carter	27516 SE Green River Gorge Rd. Black Diamond	886-1006
Maribeth Gibbons	WATER Environmental Services 9515 NE Windsong Loop Bainbridge Island	842-9382
Harry Gibbons	KCM 1917 First Avenue, Seattle	443-5300
Fran Solomon	King County SWM 700 Fifth Avenue, Suite 2200 Seattle	296-1924